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Chapter 1. Introduction

The concept of standards includes many aspects pertaining to outcomes or processes such as quality, safety, 'authenticity' and the 'goodness of the production process' (Farina and Reardon, 2000). A series of recent studies have identified the spread of 'high standards' as having a fundamental impact on the process of development (Farina and Reardon, 2000; Henson et al., 2000; McCluskey, 2007; Swinnen, 2007). And although high standards products play a much larger role in developed countries, they also affect less developed countries (LDC) through trade and FDI, etc. (Jaffee and Henson, 2005; Reardon et al., 2003; Swinnen, 2007).

Early studies predicted the rise of standards might have sharp negative impact on equity and poverty (Farina and Reardon, 2000). In contrast, the more recent research suggests a more nuanced picture of the effect of standards on poverty and development. For example, Dries and Swinnen (2004) find that high standards lead to increased vertical coordination in supply chains that is realized in their study area by the emergence of extensive contracting between processing companies and farmers. Minten et al. (2009) and Maertens and Swinnen (2009) also find increased vertical coordination in newly emerging supply chains between buyers and poor, small farmers in African countries, such as Madagascar and Senegal.

From the literature, we can find two hotly debated issues (Reardon et al., 2009): Whether the small holders are actually excluded from taking part in the high standards sector? And, does inclusion raise incomes? To address these two questions properly, we build a partial equilibrium and a general equilibrium model in Chapter 2 and 3 respectively, and then give some extensions and applications of the CGE model in Chapter 4 and 5. Even though both the partial equilibrium and the general equilibrium model are used to address the issue of standards, they have different emphases. The partial equilibrium model deals with the introduction and growth of high standards sector itself while the general equilibrium model focuses on the impact of expansion of high standards sector. Since both partial equilibrium and general equilibrium models have advantages and disadvantages, using one of them in the specific contexts of Chapter 2 and 3 is suitable.

Chapter 2 develops a formal theory of the endogenous process of the introduction of high quality products in developing countries and results from joint research with Thijs Vandemoortele, Scott Rozelle and Jo Swinnen (See Vandemoortele et al., 2009). Initial differences in income and capital and transaction costs are shown to affect the emergence of and the size of the high quality economy. Initial differences in the production structure and the nature of transaction costs – as well as the possibility of contracting between producers and processors – are shown to determine which producers are included in the high quality economy, and which not.

Chapter 3 analyzes the effects of high standards food chains on household welfare taking into account general equilibrium effects and market imperfections and results from joint research with Jikun Huang, d'Artis Kancs, Scott Rozelle and Jo Swinnen (See Xiang et al., 2010). To measure structural production changes and welfare effects on rural and urban households, our model has two types of agents, five kinds of products and four types of factors. We calibrate the model using dataset from China. The simulation results show that how poor rural households are affected depends on the nature of the shocks leading to the expansion of high standards sector and the market imperfections, and whether the poor can gain through the labor market if they are excluded from high standards farming.

Chapter 4 extends the CGE model in Chapter 3 to account for contracts. The rationale of contracts may lie in its power to overcome vertical externality and increase output and profit of processors. The profit surplus of farms due to contracts from processors may be partially transferred to processors through bargaining. We simulate decision making of processors and welfare effects of contracts. Our results show that processors may choose their credit grantees based on grantees' characteristics of both efficiency and bargaining power. The weaker bargaining power of poorest rural households increases profit transfers to the processor, and hence increases their probabilities of getting the contracts and their income accordingly.

Chapter 5 applies the CGE model to account for the impact of the dairy scandal and the following reforms in China. The scandal and the following dairy reforms in China have a huge impact on the production and marketing of milk. The peculiar structure of China's dairy sector dominated by small farmers is vulnerable to such kind of shocks. We simulate the possible impacts of the scandal and reforms by increasing preference for high standards dairy products, increasing fixed costs of dairy farming and giving subsidies to large farmers. Results show that the poorest rural households lose in nearly all the scenarios except when consumers' preference for high standards dairy products increase while import increases not a lot and when increased investment costs lead to high preference for high standards food.

Chapter 6 concludes and gives some policy implications and advices for future researches.

Chapter 2. Quality Standards and Inclusion of Small Producers in Value Chains: A Partial Equilibrium Model[1]

2.1. Introduction

Recent technological developments and globalization are transforming the industrial organization and international location of production. One of the most important mechanisms underlying the globalization process lies in the transfer of advanced production capabilities to low-wage economies. These capabilities comprise both an increase in productivity and in product quality (Eswaran and Kotwal, 1985; Goldberg and Pavcnik, 2007). Sutton (2001) argues that the quality aspect is far the more important element: poor productivity can be offset by low wage rates, but until firms attain some threshold level of quality, they cannot achieve any sales in global markets, however low the local wage level.

These quality requirements affect poorer countries through several channels.[2] First, increasing public quality requirements in richer countries are also imposed on imports and consequently have an impact on producers and traders in exporting nations (Jaffee and Henson, 2005; Otsuki et al., 2001; Unnevehr, 2000). Second, global supply chains are playing an increasingly important role in world food markets and the growth of these vertically coordinated marketing channels is facilitated by increasing quality standards (Swinnen, 2005; 2007). For example, modern retailing companies increasingly dominate international and local markets in fruits and vegetables, including those in many poorer

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[1] This chapter is based on joint research with Thijs Vandemoortele, Scott Rozelle and Jo Swinnen (See Vandemoortele et al., 2009).

[2] This chapter focuses on the development implications of changes in the demand for high quality products There are several related areas in the literature on product quality standards, including a) analyses of asymmetric information problems which may be one of the reasons for companies or public regulators to introduce standards (Fulton and Giannakas, 2004; Gardner, 2003; Leland, 1979); b) studies on the role of standards in reducing consumption externalities (Besley and Ghatak, 2007; Copeland and Taylor, 1995); c) the role of standards in providing non-tariff trade protection (Anderson et al., 2004; Fischer and Serra, 2000; Otsuki et al., 2001); and d) the political economy of standards (Swinnen and Vandemoortele, 2008).

countries, and have begun to set standards for food quality and safety in this sector wherever they are doing business (Dolan and Humphrey, 2000; Henson et al., 2000). Third, rising investment in processing and retailing in developing countries also has begun to be translated into higher quality standards, as buyers are making new demands on local producers in order to serve the high-end income consumers in the domestic economy or to minimize transaction costs in their regional distribution and supply chains (Dries and Swinnen, 2004; Dries et al., 2004; Reardon et al., 2003).

Importantly, the early literature posited that the rise of quality standards could have sharp negative influences on equity and poverty. Several of the studies argued that modern supply chains in developing countries would systematically exclude the poor and negatively affect the incomes of small farmers; in other words, it was being suggested that unlike other waves of rising economic activity, the poor would suffer from this process (Farina and Reardon, 2000). The predictions from these studies included the poorest parts of the world. For example, several studies of farm communities in Latin America and Africa argued that small farmers were being left behind in the supermarket-driven horticultural marketing and trade (Dolan and Humphrey, 2000; Humphrey et al., 2004; Key and Runsten, 1999; Reardon et al., 2003; Weatherspoon et al., 2001). In a study on Kenya, Minot and Ngigi (2004) demonstrated that modern supply chains put intense pressure on smallholders (although smallholders were still participating). Even more extreme, in the case of Côte d'Ivoire, almost all of the fruits and vegetables being produced for exports were being cultivated on large industrial estates. Likewise, Weatherspoon and Reardon (2003) argued that the rise of supermarkets in Southern Africa failed to help small producers who were almost completely excluded from dynamic urban markets due to quality and safety requirements.

Recent research suggests a more nuanced picture of the effect on poverty and its overall development implications. Dries and Swinnen (2004) find that high standards lead to increased vertical coordination in supply chains that is realized in their study area by the emergence of extensive contracting between processing companies and farmers. The rise of contracting, far from leading to the exclusion of poorer farmers, is shown to improve access to credit, technology and quality inputs for poor, small farmers that heretofore were faced with binding liquidity and information constraints due to poorly developed input markets. Minten et al. (2009) and Maertens and Swinnen (2009) also find increased vertical coordination in newly emerging supply chains between buyers and poor, small farmers in African countries, such as Madagascar and Senegal. According to their work, poor rural households experienced measurable gains from supplying high standard horticulture commodities to global retail chains. In China Wang et al. (2009) found that while rising urban incomes and emergence of a relatively wealthy middle class were associated with an enormous rise in the demand for fruits and vegetables, almost all of the increased supply was being produced by small, relatively poor farmers that sell to small, relatively poor traders. Despite sharp shifts in the downstream segment of the food chain towards modern retailing (e.g., there has been a rapid increase in the share of food purchased by urban consumers in supermarkets, convenience stores and restaurants), modern marketing chains have almost zero penetration to the farm level.

These conflicting empirical findings are puzzling. Why would one observe such different outcomes? To understand better why different outcomes may emerge, this chapter is the first[3] to develop a formal theory of the process where modern supply chains and demand signals are directing producers to grow and sell high quality and safe foods. We will use this theory to analyze whether this process may result in different outcomes when economies are characterized by different structural conditions. In particular, we analyze which producers are

[3] Exceptions are some recent studies on the relationships between the local suppliers and modern processors/retailers in developing countries focusing on vertical coordination and rent distribution (Marcoul and Veysierre, 2008; Swinnen and Vandeplas, 2007). However these studies do not seek to explain the variations in the structure of the modern supply chains that one observes.

most likely to be included in these modern supply chains, and how the inclusion process is affected by factors such as the productivity distribution of producers and the nature of the transaction costs involved. In the last part of the chapter we analyze the impact of contracting between processors and producers.

The chapter is organized as follows. In Section 2.2, we present a formal model to analyse the endogenous process of the introduction of high quality products in developing countries. We discuss the structural factors of the market equilibrium resulting from this model. Sections 2.3 and 2.4 analyze how the inclusivity of this process towards producers is influenced by respectively the production structure and the nature of transaction costs. Section 2.5 discusses the impact of contracting between processors and producers on this process and its inclusivity. Section 2.6 concludes.

2.2. The Model

The specification of the basic model that follows implements all the main features that appear to be relevant based on the literature and economic intuitions. Specifically, in the model: (a) consumers value quality as in the standard vertical product differentiation framework; (b) Producers can supply quality by undertaking production processes that are costlier than those required for the alternative, low-quality product; and (c) producers operate in a competitive industry (with free entry and exit).

2.2.1. Demand

To model the demand side, we draw upon the vertical differentiation literature. In this literature, product variants differ in their quality and consumers differ in their willingness to pay for quality (Gabszewicz and Thisse, 1979; Mussa and Rosen, 1978; Shaked and Sutton, 1982, 1983; Spence, 1975; Tirole, 1988). Ellickson (2006) examines vertical differentiation in the context of grocery retailing and Roe and Sheldon (2007) examine labelling and credence features of products using a vertical differentiation model. Moschini et al. (2008) assess the economics of geographical indications within a vertical product differentiation framework. The model in Moschini et al. (2008) is the closest one to ours in modelling demand.

We consider the unit-demand version of the standard vertical product differentiation model whereby each consumer buys at most one unit of the good. The model is adjusted for a limited number of product types and relates income directly to the preferences for quality, following Tirole (1988).[4]

Assume that there are only two types of products with different qualities in this market, a basic *low quality* (ϕ_L) product and a *high quality* ($\phi_H > \phi_L$) product. When both qualities are available, consumers choose among three options:

$$(1) \qquad U = \begin{cases} i\phi_H - P_H & \text{if the high quality good is bought} \\ i\phi_L - P_L & \text{if the low quality good is bought} \\ 0 & \text{otherwise} \end{cases}$$

where ϕ_H and ϕ_L are the qualities, and P_H and P_L are the unit consumer prices of respectively the high and low standards product; the index $i \in (I-1, I) \subseteq R_+$ represents consumer income. Consumers with higher incomes are assumed to have higher preferences for quality. The distribution of income $F(i)$ is uniform between $I-1$ and I, where the latter is the highest income among consumers. We assume that the distribution of income does not change when income grows so that an increase of aggregate income can be represented by an increase of I.

[4] Our approach implicitly assumes that the introduction of high quality reflects consumer preferences. Another reason why a company may want to introduce certain quality or process standards is to reduce transaction costs in sourcing and selling (Fulponi, 2007; Henson, 2006; McCluskey, 2007). Since the introduction of quality or process standards for these purposes would also require specific investments by suppliers (hence higher production costs) and (increased) transaction costs for the processors, most of such effects would be similar to the analysis in this chapter.

When both high quality (HQ) and low quality (LQ) products are bought by some consumers when available and some consumers buy nothing (i.e., there is an 'uncovered' market), the aggregate market demand functions Q_H^D and Q_L^D are:

(2) $$Q_H^D = M\left(I - \frac{P_H - P_L}{\phi}\right)$$

(3) $$Q_L^D = M\left(\frac{P_H - P_L}{\phi} - \frac{P_L}{\phi_L}\right)$$

subject to $\frac{P_L}{\phi_L} + 1 > I > \frac{P_H - P_L}{\phi}$, where M is the total number of consumers in this economy and $\phi \equiv \phi_H - \phi_L$ represents the quality difference. If $I < \frac{P_H - P_L}{\phi}$ there will be no demand for high quality products $\left(Q_H^D = 0\right)$.[5]

2.2.2. Supply

On the supply side, we assume a standard competitive industry populated by numerous producers who behave as price takers. In our model all producers are able to produce either the high quality or the low quality product. To start, we assume that producers are identical. Later in the chapter we will relax this assumption and analyze how producer differences affect their integration into the high quality economy.

We assume further that producers have a production technology that requires a unit cost c_H and c_L, for the high and low quality product respectively, and that $c_H = c_L + k$, where k is the per unit additional capital costs for producing the high quality product.[6] Finally, for simplicity, we assume that the other costs remain the same and that producers can

[5] See Gabszewicz and Thisse (1979) and Tirole (1988) for formal derivations of these conclusions.
[6] We ignore quality uncertainty, so each farm can meet the processor's quality threshold with certainty if it makes a predetermined capital investment. We also currently ignore issues of contracting and contract enforcement in the HQ chain. For more details about this, see Swinnen and Vandeplas (2007) who show that the premium itself will depend on the contract enforcement conditions.

produce the same number of units of the commodity regardless of whether they produce low quality or high quality commodities.[7]

2.2.3. Marketing and Trade

Once the products are produced in response to consumer demand, our model needs to account for the transfer of the commodities from farm to plate. For simplicity we assume that one unit of production is identical to one unit at retail (consumer) level for both high and low quality. We use different marketing assumptions for the LQ products and the HQ products. We assume that producers sell their LQ commodity in villages and city markets at price P_L under perfect competition. For the HQ supply chain, we assume that 'processors' (which may represent any company involved in processing, marketing or retailing) purchase the HQ commodity from producers at price p_H and resell this commodity to consumers at price P_H. We consider that these companies incur a unit transaction cost τ in sourcing from producers. Under perfect competition and free entry and exit for processors, it follows that the consumer price of the commodity is the sum of the producer price and the transaction cost, such that $P_H = p_H + \tau$.[8]

[7] This assumption is consistent, for example, with a farmer who may produce 100 litres of non-cooled, high-bacteria milk if operating in the low quality market or, after an investment in a cooling tank is made, 100 litres of cooled, low-bacteria milk if operating in the high quality market.

[8] We ignore 'processing costs' because they only complicate the mathematics but do not affect the conclusions. We also considered an alternative model with a monopolistic market structure in processing. Again, this vastly complicated the model without yielding substantial differences in the key results regarding the issues where this chapter focuses on. See Swinnen and Vandeplas (2007) for an analysis of the role and effects of competition in the emergence and growth of a high quality economy.

2.2.4. Structural Factors and the Market Equilibrium

With producers' supply of low and high quality products determined by their respective marginal costs c_L and c_H and the demand functions (2) and (3) we can derive the market equilibrium level of LQ products $\left(X_L^*\right)$ and HQ products $\left(X_H^*\right)$ as follows:

(4) $$X_L^* = M\left(\frac{k+\tau}{\phi} - \frac{c_L}{\phi_L}\right)$$

(5) $$X_H^* = M\left(I - \frac{k+\tau}{\phi}\right)$$

Equations (4) and (5) incorporate the relationship between a series of structural variables and the relative importance of the high and low quality economies. For each of the key variables $\left(I, k, \tau, \phi\right)$ one can identify threshold levels (either minima or maxima) for the high quality economy (HQE) to exist, i.e. for $X_H^* > 0$. For positive levels of X_H^*, one can use comparative statics to show how the variables affect the size of the HQE.

Income $\left(I\right)$. The size of the HQE is directly related to the level of income in the economy. A minimum level of income is required for a HQE to emerge. Formally, the condition is: $I > \frac{k+\tau}{\phi}$. Hence, one of the basic results that falls out of our model is consistent with the observation that HQ markets are more likely found in countries with higher incomes than in countries with lower incomes. Additionally, once income is above this threshold, the model shows that the HQE becomes larger when income increases $\left(\frac{\partial X_H^*}{\partial I} = M > 0\right)$. The positive effect of I on X_H^* is also consistent with the observation that HQ production systems tend to emerge first in export sectors in developing countries. For example in many African economies HQ production is limited to supply chains targeted to (high income) EU consumer markets while production for domestic markets is limited to LQ production.

Capital costs (k). In many developing countries capital constraints are important and the real cost of capital is high. According to our model this is another reason that HQ markets are less likely to emerge in developing countries. If capital costs of producing HQ are too high, i.e. if $k > \phi I - \tau$, then no HQE will emerge. Moreover, given that a HQE exists, the size of the HQE will be smaller if capital costs are higher, as $\frac{\partial X_H^*}{\partial k} = -\frac{M}{\phi} < 0$.

Quality difference (ϕ): An additional condition for the emergence of a HQE is that the high quality level is sufficiently larger than the low quality level, given the extra cost of that quality difference. Formally, the quality difference ϕ must be such that $\phi > \frac{k+\tau}{I}$ holds. Given that this condition is fulfilled, the HQE will be larger for larger quality differences $\left(\frac{\partial X_H^*}{\partial \phi} = \frac{M\left(k+\tau\right)}{\phi^2} > 0 \right)$.

However, as we will show in the next sections, these conclusions need to be nuanced when one allows explicitly for details on the production structure as well as on the nature of transaction costs in the model.

2.3. Production Structure

In addition to being able to predict the factors that underlie the emergence of the HQE, our model can also be used to gain insights on what types of producers are most likely to join the HQE (when it emerges) and what types of producers will likely be left out. As discussed in the introduction, this issue has attracted a lot of policy attention and academic debate. Some studies have argued that smallholders are excluded from HQE due to scale diseconomies (Reardon et al., 2009) and higher transaction costs (Minten et al., 2009); others have argued that this is not (necessarily) the case (Reardon et al., 2009).

The arguments used in the literature are often quite simplistic. In fact, they may also be *too* simplistic. For example, the impact of scale economies is not as trivial as often argued.[9] Scale economies can differ strongly between activities (e.g. extensive grain farming compared to intensive vegetable or dairy production) and may be influenced by local institutions and market constraints.

Since the impact of scale economies can be ambiguous, contingent on the type of commodities, in our analysis here we focus on two other more direct factors, the initial production structure of the economy (productivity heterogeneity in our model) and the nature of the transaction costs. We will show that both factors have an important impact on the size of the HQE and on who is included in the HQE.

One of our key arguments is that initial conditions matter. One might expect different outcomes from the emergence of the HQE in rural settings that have highly unequal distributions of land resources (such as in some nations in Latin America and parts of the former Soviet Union—which have some individuals holding massive estates and many smaller, relatively poor farmers), compared to rural societies characterized by more egalitarian distributions of cultivated land (e.g., China, Vietnam and Poland). In the rest of the analysis we call this the *production structure* of the rural economy. In this section we will formally show that the initial production structure indeed matters: the share of smallholders in the production system – and the existence of large holdings amongst the smallholders – will affect both the size of the HQE and the integration of smallholders into the HQE. To analyze this we relax the assumption of a homogenous producer structure. This means that k

[9] There is an extensive literature showing how farm productivity, and in particular the relationship between size and productivity, tends to differ importantly by commodity (e.g. Allen and Lueck, 1998; Pollak, 1985). For example, while large producers may have scale advantages in land intensive commodities, such as wheat or corn, this is typically much less the case in labor intensive commodities, such as fruits and vegetables. In fact, there are cases in which small-scale producers may have advantages over larger farmers. In the production of some HQ commodities, small farmers may have an advantage over larger farmers because of the importance of labor governance and the quality of the labor input. This implies that the inclusion or exclusion of small farms is likely to depend importantly on the type of the commodity. This is consistent with findings from Wang et al. (2009) on China and Minten et al. (2009) on Madagascar which find that smallholders are extensively included in labor intensive fruits and vegetable production.

is not necessarily identical for all producers. In line with our general model, we introduce producer heterogeneity by varying the capital cost k.

We assume that capital cost k_j for producer *j* follows a Markov process independent across producers[10] and is uniformly distributed across *N* producers with $k_j \in [k-\gamma_k, k+\gamma_k]$ $\forall j = \{1,...,N\}$ and $\gamma_k \in [0,k]$ with $k \geq 0$. For simplicity, we assume that individual producers only produce one unit of the high standards product, when they are involved in the HQE.[11] This is a strong but widely-used assumption (see e.g., Keuschnigg and Ribi, 2009; Van Long et al., 2007).[12, 13] Producers with lower capital costs are more efficient.

We can now consider variation in the production structure by considering changes in γ_k. Specifically, the extreme case of homogeneous farms – which was the assumption in the first part of the chapter – is represented by $\gamma_k = 0$. The efficiency distribution is increasingly unequal as γ_k increases. With any given distribution, the average efficiency is represented by capital cost *k* (as in the general model).

The supply curves for heterogeneous and homogeneous production structures are shown in Figure 2.1. In this graphical representation $X_H^S(\gamma_k = 0)$ represents the supply function for homogeneous producers. Likewise, $X_H^S(\gamma_k > 0)$ is the supply function for heterogeneous producers.

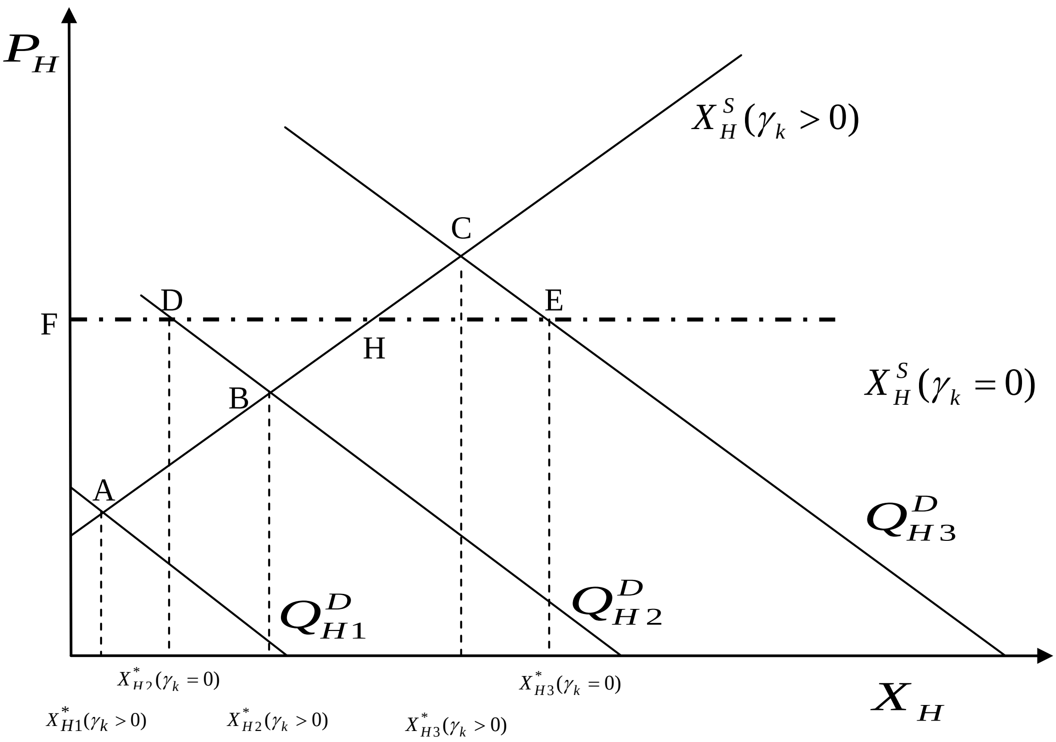
[10] This assumption is widely used in the literature on trade, e.g., Hopenhayn (1992) and Melitz (2003). Following this assumption the equilibrium in our model can be regarded as a stationary equilibrium (Hopenhayn, 1992). Under this assumption, industrial positive profits can co-exist with free entry.

[11] Alternatively, one could fix the inputs and consider variation in output, or consider variations in input and/or output size. Our specification is closer to the basic model specification and allows to derive the key results.

[12] The assumption is sufficient to guarantee that production capacities of farmers are limited, which is necessary to allow for co-existence of free entry/exit and heterogeneous farmers. Otherwise, if the capacities are unlimited, the most productive farmers will dominate the market and exclude all other farmers.

[13] By this assumption, we rule out scale economies. This assumption can be relaxed, at the cost of additional complexity, without affecting our basic results, because the critical to aggregate individual output to get market supply is the productivity of the producer which is indifferent between producing for the HQE and for the LQE. As we can see later, our main result is that more heterogeneous production structure will induce early emergence of HQE but with less expansion speed after its emergence. This result does not depend on the source of heterogeneity. Any kind of heterogeneity will finally lead to the heterogeneity of productivity, which is critical in our analysis.

Figure 2.1 HQ Production under Different Production Structures



When producers choose to produce the HQ products, under the assumption that one producer produces only one unit of output in the HQE, their profits[14] are $p_H - c_H$, with $c_H = c_L + \tilde{k}$ where $\tilde{k}$ is the capital cost of the producer that is indifferent between producing for the HQE and the LQE. Using this, we can then derive the aggregate supply of HQ products as:

(6) $$X_H^S = \frac{N}{2\gamma_k} \int_{k-\gamma_k}^{\tilde{k}} dk_j = \frac{N\left(\tilde{k} + \gamma_k - k\right)}{2\gamma_k}.$$ [15]

This, in turn, leads to a new expression for the equilibrium quantity in the HQ market:

[14] Based on our assumptions, the profits will be kept by the involved producers. In reality, the profits will be shared between producers and processors according to their bargaining powers (Swinnen and Vandeplas, 2007).

[15] When $\gamma_k = 0$, the HQ output X_H^S is completely determined by demand in the equilibrium (perfectly elastic supply) and equation (7) is irrelevant.

(7) $$X_H^* = M\left(I - \frac{(k - \gamma_k + \tau)}{\phi}\right)\left(\frac{1}{1 + \frac{M/\phi}{N/2\gamma_k}}\right).$$

Comparing (5) and (7) yields some important insights. The second term of the right hand side (RHS) of condition (7) shows that the HQE will emerge at lower income levels with a heterogeneous production structure than with a more homogeneous structure. Specifically, $I > \frac{k - \gamma_k + \tau}{\phi}$ is the condition for the HQE to emerge. With $\gamma_k > 0$ the required income level is lower than when $\gamma_k = 0$. In addition, the required income level (for the emergence of a HQE) declines when the distribution is more unequal (that is, when γ_k is higher). The intuitive reason for this finding is that when an economy faces a more heterogeneous production structure, this implies that there are more efficient producers among the entire set of producers, *ceteris paribus*. As a result of this, these producers will be able to produce HQ products when it is not possible when the economy is characterized by a homogeneous production structure.

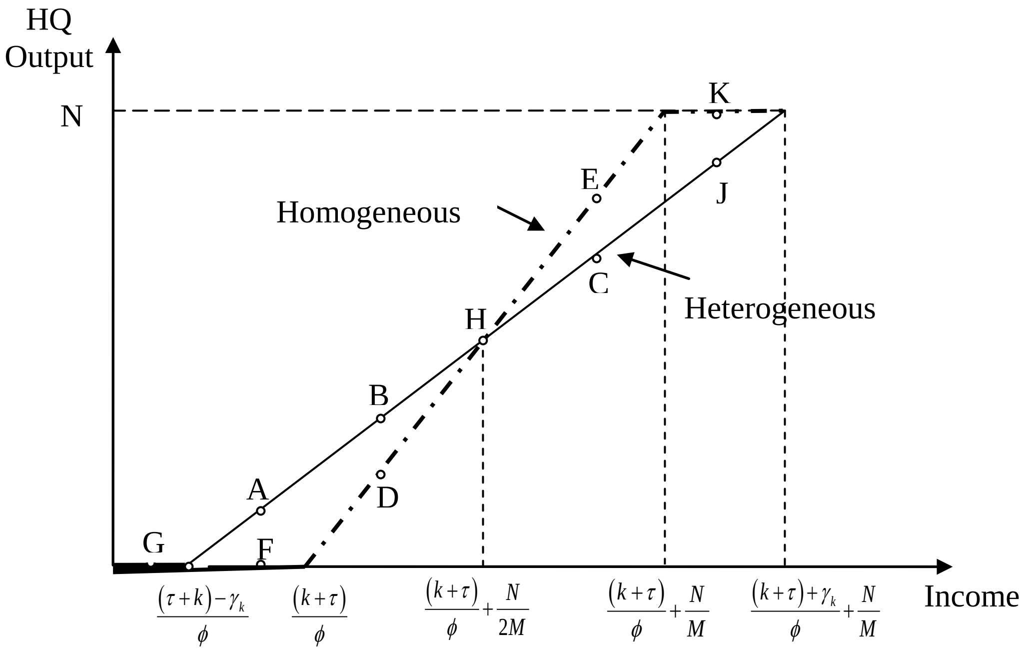
However, the third term of the RHS of condition (7) implies that the expansion of HQ production – once it exists – proceeds more gradually when there is a heterogeneous distribution of farms. To see this, define $B = 2M\gamma_k/N\phi$. The third term then equals $1/(1+B)$, which is less than 1 with $B > 0$. Formally, $\partial X_H^*/\partial I = \frac{M}{1+B}$. With $B = 0$ when $\gamma_k = 0$, and $\partial B/\partial\gamma_k > 0$, it follows that the growth in X_H^* with increasing income will be more gradual when there is a more heterogeneous set of producers – given that $X_H^* > 0$. These results are illustrated in Figure 2.1.

In Figure 2.1 $X_H^S(\gamma_k = 0)$ represents the supply function for homogeneous producers and $X_H^S(\gamma_k > 0)$ the supply function for heterogeneous producers. For low income, represented by demand function Q_{H1}^{D} for high standards products, the equilibrium output in the high standards market is zero with homogeneously distributed producers, i.e. $X_{H1}^{*}(\gamma_k = 0) = 0$. In contrast, under a heterogeneous producer structure, the HQE does emerge and the equilibrium is at point A. HQ output is equal to $X_{H1}^{*}(\gamma_k > 0)$. For increasing higher income levels, represented by demand curves Q_{H2}^{D} and Q_{H3}^{D}, the market equilibrium with the heterogeneous structure shifts to points B and C, respectively. For the homogeneous production structure, there will also be positive HQ output at Q_{H2}^{D} and Q_{H3}^{D}, represented by points D and E, respectively.

Figure 2.1 thus illustrates that HQ production emerges at lower levels of income for heterogeneous structure (represented by point A). However, once the HQ emerges in an economy characterized by a more homogeneous structure, the growth of HQE is more rapid as income grows. When examining Figure 2.1, note that the growth of production is represented by the shift from point D to E is larger than for the shift from B to C.

These results are further illustrated in Figure 2.2. When income is too low $\left(I < \frac{k + \tau - \gamma_k}{\phi}\right)$ as illustrated by point G, there is no HQE under either the heterogeneous or homogeneous structure. As income increases, however, the HQE emerges first in the economy characterized by a heterogeneous production structure for $I > \frac{k + \tau - \gamma_k}{\phi}$, shown by point A. Under the assumption that a nation’s production structure is more homogeneous, the minimum income requirement for the emergence of a HQE is higher $\left(I > \frac{k + \tau}{\phi}\right)$. When income is low $\left(\frac{k + \tau - \gamma_k}{\phi} < I < \frac{k + \tau}{\phi}\right)$, a HQE exists under the heterogeneous structure (point A), but does not (yet) exist under the homogeneous structure (point F). At higher

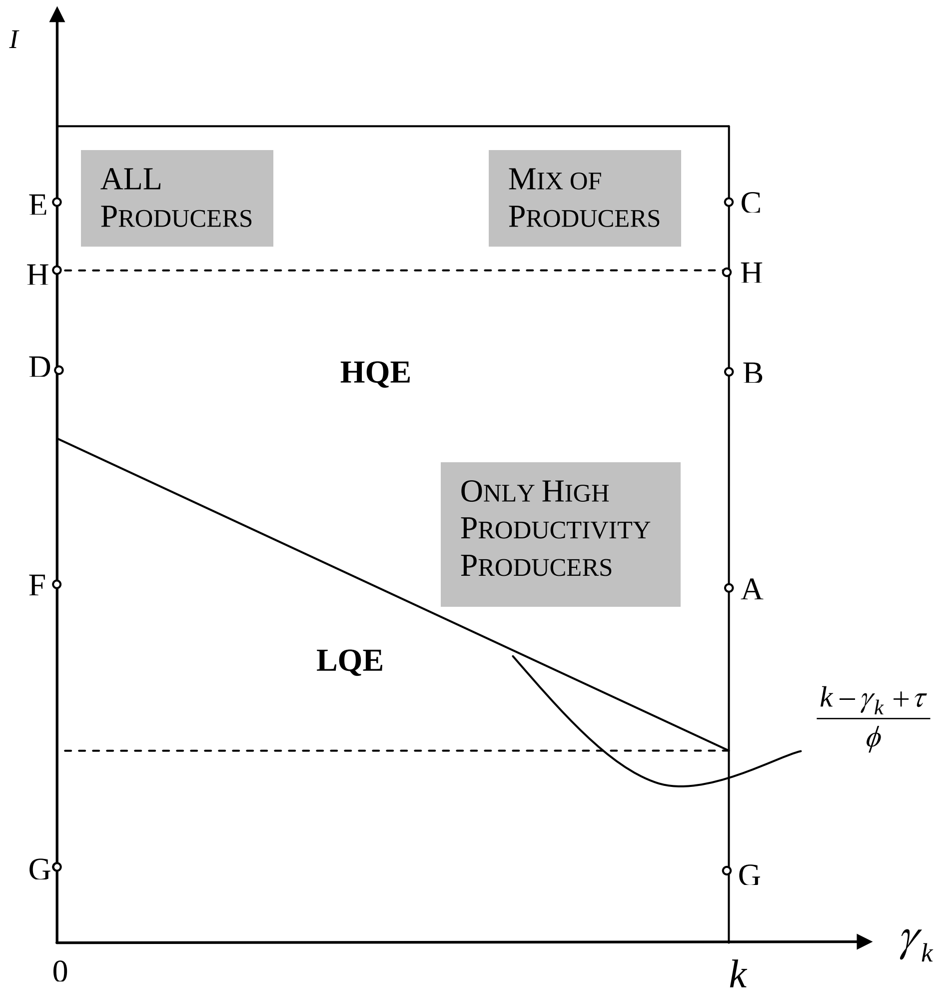
Figure 2.2 Size of the HQE under Different Production Structures



incomes, HQ production is also positive for the homogeneous structure, but output remains higher for heterogeneous production structure, as long as income does not reach the level $I=\dfrac{k+\tau}{\phi}+\dfrac{N}{2M}$ (Point H). At higher incomes, the homogeneous producer structure produces higher output. Finally, when income is larger than $\dfrac{k+\tau}{\phi}+\dfrac{N}{M}$ but lower than $\dfrac{k+\tau+\gamma_k}{\phi}+\dfrac{N}{M}$, the HQE will include all producers under the homogeneous structure in contrast to the heterogeneous structure, shown respectively by points K and J.

This approach also allows to analyze *who is included in the HQE*. With a heterogeneous production structure, the most productive farms will start producing HQ at low income levels. However, given the same set of incomes and other factors, the less productive farms will be excluded. When the production structure of an economy is more homogeneous, HQ production will only start at higher income levels. Although beginning later in the development process, once started the process will be more inclusive. More producers will be included. This insight can be seen graphically in Figure 2.3. The line that divides the graph between the LQE and the HQE is characterized by $\frac{k-\gamma_k+\tau}{\phi}$, which is the minimum income level required for a HQE to emerge under given producer heterogeneity γ_k. It illustrates again that when producers are more heterogeneous, there is a more rapid emergence of the HQE—given certain levels of income growth. In addition, under our assumption that more productive producers have lower capital costs k_j, Figure 2.3 also illustrates that when income increases, a homogeneous producer structure is more inclusive towards low productivity producers. At high levels of income, all producers will be included under any distribution.

Figure 2.3 Combined Impact of Production Structure and Income on HQE



2.4. Transaction Costs

The nature of transaction costs is another fundamental feature of an economy that can affect the HQE. First, transaction costs will affect the overall size of HQ production. Higher transaction costs constrain the size of the HQE ($\frac{\partial X_H^*}{\partial \tau} = -\frac{M}{\phi} < 0$, see equation (5)). It makes sourcing from suppliers more costly and therefore increases the relative cost of the HQ products.

Second, transaction costs will also affect *who is included*. In the literature, a standard argument is that there are fixed transaction costs per supplier for processors (Reardon et al., 2009). This implies that transaction costs per unit of output are lower for large producers and hence small producers will be excluded. However, such conclusion is overly simplistic and depends on the specific (often implicit) assumptions on the nature of the transaction costs. In reality there are different types of transaction costs that might be important when processors source HQ commodities from producers. Transaction costs may or may not be related to producers' productivity. For example, one common type of transaction costs might include costs of search (by company procurement agents that are looking for producers that are willing to supply to the HQE), supervision costs, quality and process control costs and the costs of enforcement of agreements (Key and Runsten, 1999). Supervision costs and quality control costs may depend on productivity of producers while search costs and enforcement costs have no clear relationship with producers' productivity. As an illustration, consider the following example from Minten et al. (2009), which studies processor-farmer interactions in a HQ vegetable production region which produce horticultural exports in Madagascar for the European Union:

> *'To monitor the correct implementation of the [HQ] conditions, the [processor] has …around 300 extension agents who are permanently on the payroll of the company. Every extension agent … is responsible for about thirty farmers. To supervise these, (s)he coordinates [another] five or six extension assistants ... that live in the village itself. … During the cultivation period of the [HQ] vegetables, the [farmer] is visited*

> *on average more than once (1.3 times) a week …to ensure correct production management as well as to avoid 'side-selling'. …99% of the farmers say that the firm knows the exact location of the plot; 92% of the farmers say that the firm even knows …the number of plants on the plot.*
> *'For some crucial aspects of the production process, representatives of the company will even intervene in the production management to ensure it is rightly done.'* (p. 1733).

This example clearly illustrates that the notion of fixed transaction costs per supplier is not (necessarily) consistent with reality. For conceptual purposes, one could distinguish three types of transaction costs: those which are fixed per supplier (e.g. contract negotiation costs), those which are fixed per unit of output (e.g. output control costs) and those which are fixed per unit of production input (e.g. monitoring of plots and production activities).

To show that these different types of transaction costs will have different effects in the emergence, size and composition of the HQE, we compare two types of transaction costs: on the one hand transaction costs which are fixed per supplier and on the other hand transaction costs which are fixed per unit of input. Note that if we would fix transaction costs per supplier, this would be equivalent to transaction costs which are fixed per unit of output, as our model assumes identical output levels across producers. More specifically, we assume that τ_j is a producer (supplier) -specific transaction cost. It is uniformly distributed over the interval $\left[\tau-\gamma_\tau,\tau+\gamma_\tau\right]$ with $\gamma_\tau \in \left[0,\tau\right]$ and $\tau \geq 0$. With transaction costs defined in this way, we first consider the case when transaction costs are fixed per producer. This means that transaction costs are identical for all producers (or, $\gamma_\tau = 0$ and $\tau_j = \tau$). In the second case, we consider transaction costs which are fixed per unit of input. This implies that transaction costs are negatively related to producer productivity, i.e. $\partial\tau_j/\partial k_j > 0$, which implies $\gamma_\tau > 0$.

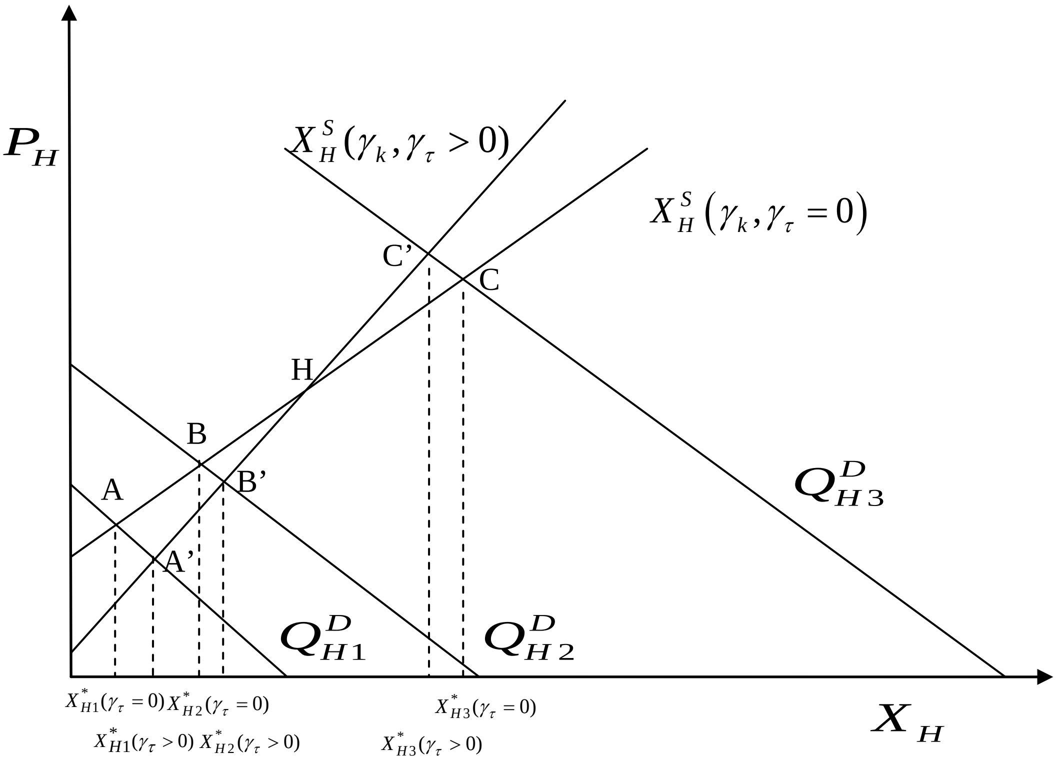
It is immediately clear that these different types of transaction costs will have fundamentally different implications for which producers will be included in the HQE. In one case, the transaction costs will be 'neutral' regarding productivity heterogeneity; in the other case, they will reinforce the productivity-bias. Formally this can be seen from the new condition for the equilibrium output of HQ products with producer specific transaction costs:

$$X_H^* = M\left[I - \frac{(k-\gamma_k)+(\tau-\gamma_\tau)}{\phi}\right]\left(\frac{1}{1+\dfrac{M/\phi}{N/2(\gamma_k+\gamma_\tau)}}\right). \tag{8}$$

It follows from equation (8) that the structure with heterogeneous transaction costs, i.e. $\gamma_\tau \neq 0$, will induce earlier emergence of HQE for increasing income levels. The HQE arises when $I > \frac{\tau + k - \gamma_k - \gamma_\tau}{\phi}$, which is less restrictive for higher γ_τ (more heterogeneity in transaction costs).

Figure 2.4 illustrates this effect. The HQ supply function with fixed transaction costs

Figure 2.4 HQ Production under Different Types of Transaction Costs



$(\gamma_\tau = 0)$ per supplier is identical to that of Figure 2.1 with heterogeneous suppliers.[16] It follows from equation (8) that with heterogeneous transaction costs, the HQ supply function pivots around point H. This implies more HQ supply at lower levels of income (represented by Q_{H1}^{D}) but less supply at higher levels of income. As is illustrated in Figure 2.4, the negative relation of transaction costs with productivity reinforces the productivity effect in this pivot of the supply function.

The impact - on who gets included when the nature of transaction costs is taken into account - is also analogous to the discussion over the production structure of the economy. Low productive suppliers will be less likely included with transaction costs fixed per unit of input, and vice versa. In this way, transaction costs reinforce the productivity effect, in the sense that they reduce the purchasing costs for processors from more productive farms. Farms with higher productivity will have even more cost advantages because the per unit transaction costs are lower. However, this result depends on the nature of 'transaction costs'. If fixed transaction costs are per farm, this is not the case.

Notice that one should be careful in interpreting these findings. Our specific findings are conditional on our model specification, which assumes there is a fixed output per farm. However, our main result, i.e. that the impact on the inclusion in the HQE depends on the nature of the transaction costs, holds in general. In reality, some transaction costs are fixed per farm, such as those for bargaining and search. Other costs however, such as product or process control costs, would at least have a component that is better modelled as per unit of output or input cost. To the extent that these variable transaction costs are more important, the cost advantage of large and more productive farms will change. Another issue is the

[16] Note that in case of homogeneous suppliers, there is no effect of the nature of the transaction costs on who get included since all suppliers (and thus their transaction costs) are identical.

distribution of the profit due to low transaction costs. Generally, it depends on the contribution and bargaining power of the involved players (Swinnen and Vandeplas, 2007).

2.5. Contracting

In developing countries, processing firms or large traders are often less capital constrained than producers. As a consequence of this asymmetric capital market imperfection, processors and producers may start a process of vertical coordination or contracting by which the processors supply the producers with the capital necessary to produce the high quality product. This is consistent with empirical observations that the introduction of higher quality requirements in transition and developing countries has coincided with the growth of contracting (Swinnen, 2007). Empirical studies show that local producers in developing countries are engaging in complex contracting with processors selling into high quality markets. These contracts not only specify conditions for delivery and production processes but also include the provision of inputs, credit, technology, management advice etc. (Minten et al., 2009; World Bank, 2005b). The latter are particularly important for local producers who face important local factor market imperfections. If the institutional environment is such that producers and processors have the possibility to contract the production of high quality products, this may have important implications for the emergence, growth, size, and inclusivity of the HQE.

To analyze the impact of contracting in our HQE framework, we use a simplified version of the contract model that is typically used to study these problems.[17] Different from the basic model, we assume that, due to the imperfect credit market, each producer can have a maximum amount of capital ($\bar{k}$), either self-owned or borrowed.

[17] See Swinnen and Vandeplas (2007) for an extensive analysis of such models and the impact of competition and imperfect enforcement on (the efficiency of) contracting between processors and producers.

When processors contract with producers, we assume that processors can provide an individual maximum capital k_p to producers to produce the high quality product. Producers will participate in this type of contracting if the producers' capital cost k_j is larger than the producer's capital constraint but lower than the total capital after getting capital from processors.

As before, we assume that the individual capital cost k_j differs among producers and is uniformly distributed, but for simplicity we assume identical transaction costs τ (i.e. transaction costs are fixed per producer).

The indifferent capital cost between producing for the HQE and the LQE can be derived from combining equations (2) and (6) with $P_H = c_L + \tilde{k} + \tau$ and $P_L = c_L$:

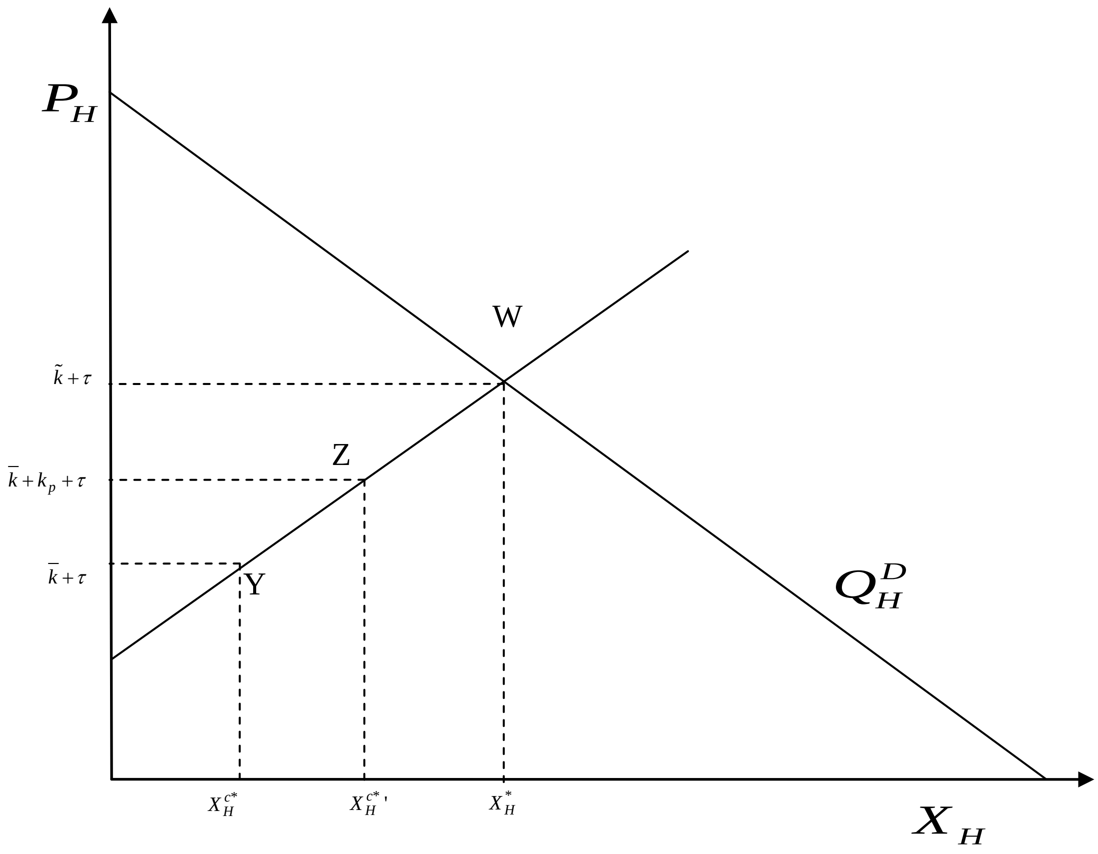
(9) $$\tilde{k} = \frac{\phi I - \tau}{1 + 1/B} + \frac{k - \gamma_k}{1 + B},$$

with $B = \dfrac{2M\gamma_k}{N\phi}$ as before. This assumption means that the economy cannot arrive at the equilibrium point W in Figure 2.5 without extra capital input.

Whether contracting has an impact on the market equilibrium in the HQE depends on whether $\bar{k} \geq \tilde{k}$ or $\bar{k} < \tilde{k}$. First, consider the situation where $\bar{k} \geq \tilde{k}$. In this case the possibility of contracting does not impact on the HQE as contracting will not occur. All producers with $k_j \leq \tilde{k}$ participate in the HQE. And as $\bar{k} \geq \tilde{k}$, no producer involved in the HQE needs to contract with a processor.

Second, when $\bar{k} < \bar{k} + k_p < \tilde{k}$, contracting does have an impact on the emergence, size, and inclusivity of the HQE. In Figure 2.5, the equilibrium without contracting is depicted by point Y and the contracting equilibrium by Z, where $X_H^{c*}{}'$ is the equilibrium HQ output under contracting. Conditional on $\bar{k} + k_p < \tilde{k}$, the equilibrium HQ output under contracting is

Figure 2.5 Impact of Contracting on the HQE Equilibrium



determined by the constrained supply:

$$(10) \qquad X_H^{c*}\,' = \frac{N\left(\bar{k}+k_p+\gamma_k-k\right)}{2\gamma_k}.$$ [18]

which is larger than the equilibrium HQ output without contracting $X_H^{c*} = \dfrac{N\left(\bar{k}+\gamma_k-k\right)}{2\gamma_k}$.

Straightforwardly, contracting will have an impact on the emergence of the HQE when $\bar{k} < k-\gamma_k < \bar{k}+k_p$ and $k-\gamma_k < \tilde{k}$.

Therefore, contracting has impacts on HQE. First, the HQE will be larger with the possibility of contracting, i.e. $X_H^{c*}\,' > X_H^{c*}$, which is clear in Figure 2.5. By relaxing capital

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[18] If $\bar{k} < \tilde{k} < \bar{k}+k_p$, the equilibrium HQ output under contracting is $X_H^{c*}\,' = \dfrac{N\left(\tilde{k}+\gamma_k-k\right)}{2\gamma_k}$.

constraints of producers with $k_j > \bar{k}$, contracting enlarges the set of producers who are able to produce the high quality product at a given equilibrium price. Second, contracting between processors and producers induces the HQE to become more inclusive towards less productive producers.

In conclusion, if processors can relax credit constraints of producers, contracting will improve the size, growth, and inclusivity of the HQE, and in extreme cases it may even lead to an earlier emergence of the HQE. This linkage between the capital constraint, contracting, and the emergence of the HQE offers an explanation for the empirical observation foreign direct investment (FDI) play an important role in the emergence of HQEs (e.g. Dries and Swinnen, 2004). Processors have developed VC arrangements with supplying farms to provide capital inputs to farms who are capital constrained, either because of the collapse of the financial system (e.g., in transition countries – see Gow and Swinnen, 1998; World Bank, 2005a) or because of general credit constraints of farmers in developing countries (e.g., Minten et al., 2009; Maertens and Swinnen, 2009). To set up such VC arrangements, processors themselves need sufficient access to capital. This is why FDI – or other institutional arrangements which enhance the access of processors to capital markets have played an important role. While FDI may have more than one effect on the emergence of a HQE, a crucial element is that, with capital market imperfections in developing countries, foreign companies frequently face less restrictive credit constraints than domestic companies in developing countries. Because of this, foreign firms may therefore be able to invest when it is not possible for domestic companies to do so.[19] Through VC this, in turn, leads to reduced

[19] In some cases, access to capital has also come from (domestic) company investments which have other sources of capital (such as the case of Russia in which there are energy firms that are willing to invest in domestic firms) or through supply contracts with international traders (as in cotton markets in Central Asia – Swinnen, 2007).

capital constraints for farmers with FDI. Section 2.5 clearly showed the beneficial impact of contracting on the emergence of the HQE in line with the empirical observations.

2.6. Conclusions

In this chapter we have developed a formal theory of the process of the endogenous introduction of high quality products in developing countries. We use our theoretical model to analyze how different structural conditions of the economy affect the emergence and size of the high quality economy (HQE). Differences in the form of the level of income, the relative cost of capital, the extent and nature of transaction costs and whether the production structure is homogeneous or heterogeneous will affect the timing of the emergence and the size of the HQE. These results can be used to gain insights on how institutional reforms, including macro-economic stabilization, liberalization of trade and foreign investment regulations can have important impacts on the growth of the HQE. In particular, these and any other policy change that reduces the cost of capital, according to our model, will play an important role in stimulating the growth of the HQE.

We also examine which factors affect who is able to participate in the HQE as it is emerging. Not surprisingly, we find that the most productive farms switch first to producing for the HQ market. Importantly, our analysis shows how the nature of the initial production structure can affect both the size and distributional effects of the HQE. In countries with a mixed production structure, combining large and medium size commercial farms with small-scale household farms, such as in Latin America and parts of Eastern Europe and the former Soviet Union, the process is more likely to lead to an initial exclusion of smallholders from the HQE. In contrast, in countries such as China and Vietnam, India and parts of Africa, Eastern Europe and Central Asia, where the farm sector is more uniform and dominated by small farms, the emergence of the HQE, although delayed, can be expected to be more inclusive.

Transaction costs also play an important role as they may or may not reinforce the disadvantaged position of less productive producers – depending on the nature of the transaction costs. Reducing these transaction costs, for example by investments in infrastructure, producer associations, third party quality control and monitoring institutions, could also play a role in reducing the bias against small and less efficient producers and speed their integration into the HQE.

Additionally, we show that contracting between producers and processors may induce the HQE to be more inclusive towards less efficient producers through increased access to capital. We also explain how foreign direct investment may play an important role in this way.

Therefore, similar to the empirical literature, our model shows that less productive farms are excluded from modern supply chains, that less productive farms face more intense pressure than more productive farms, and that vertical coordination (contracting) allows some less productive farms to be included in modern supply chains.

While this chapter is the first attempt to model the introduction of HQ products in developing countries, we realize that our analysis is only the first step. Several issues in this process require more analysis. First, the farm heterogeneity issue and its relation with the HQE which has been the subject of extensive empirical analysis and debate, requires more extensive analysis. Second, the interactions between the processors and the producers in the HQE are either modelled as spot market transactions or as simple contracts in which processors provide producers with capital at a lower cost. However, there is substantial empirical evidence that this relationship is often more complicated, taking the form of complex contracts or other forms of vertical integration. These different governance forms that are observed in the HQ supply chain will affect both the emergence and size of the HQ chain.

While policies and institutions are not explicitly in our model, they do affect the equilibrium indirectly through their effect on the various factors which we have discussed. A few examples may indicate how an extended version of our model could be used to capture such policy effects. For example, if foreign investment rules were liberalized, they could stimulate the HQE through their effect on the inflow of FDI and reduced capital constraints for producers. Public investments in infrastructure and institutions that promote quality control and food safety institutions could stimulate the HQE by reducing transaction costs in the HQ market. Economic and institutional reforms could also have non-linear dynamic effects on the HQE if they initially increase the cost of capital because of disruptions (as they did during the early years of the transition in Eastern Europe). In the longer run, however, institutional reform reduces the cost of capital as the more efficient, post-liberalization economic system develops. More generally, policies which affect macro-economic uncertainty and the security of property rights for investors are likely to affect the emergence and size of the HQE through their effects on the cost of capital for producers, either directly or through the profitability of VC arrangements.

Finally, to further complete the analysis one should also look at the interaction with labor markets. HQ investments will affect labor markets as the new investments create off-farm employment both inside the processing facility, as well as in the service sector (e.g., in the areas of extension, packaging, supervision, controlling, marketing and transport). Some – or most – of these jobs are low skilled and may be taken by the poorest of the poor. Empirical studies indicate that if HQ production takes place through vertically integrated company-owned farms, this may have different effects on rural households than when they can start producing HQ commodities themselves (see e.g. Maertens and Swinnen, 2009; Maertens et al., 2008).

In summary, all these factors should be considered when attempting to analyze the effect of the emergence of HQ markets on households in developing and transition countries. These combined effects are likely to be complex. These and other issues should be the focus of future research and we hope that such models can build upon the theoretical framework that is developed in this chapter.

Chapter 3. Food Standards and Welfare: A General Equilibrium Model with Market Imperfections[20]

3.1. Introduction

A series of recent studies have identified the spread of 'high standards' as having a fundamental impact on the process of development (Farina and Reardon, 2000; Fulponi, 2007; Henson et al., 2000; McCluskey, 2007; Reardon et al., 2009; Swinnen, 2007). The growing demand of wealthy consumers for high quality, safety, health, and ethical standards put pressure on governments to increase public regulatory standards and on private processing and retailing companies to introduce or tighten private corporate standards (Swinnen and Vandemoortele, 2008). Generally, growing demand for high standards is a natural consequence of income growth (Vandemoortele et al., 2009). In recent years it has been reinforced by several additional events. For example, international campaigns against child labor and genetically modified food, NGO activities for the environment and several food safety crises, such as the food dioxin crisis and the appearance of BSE in Europe, have all contributed to a rising demand for high quality, safe and traceable products in the production chains of many nations.[21]

Although high standards emerged initially in rich countries, they now affect poorer countries through several channels. First, standards in richer countries are also imposed on imports and consequently have an impact on producers and traders in exporting nations (Jaffee and Henson, 2004; Unnevehr, 2000). Second, global supply chains are playing an

[20] This chapter is based on joint research with Jikun Huang, d'Artis Kancs, Scott Rozelle and Jo Swinnen (See Xiang et al. (2010)).

[21] This chapter focuses on the development implications of changes in the demand for high quality products There are several related areas in the literature on product quality standards, including a) analyses of asymmetric information problems which may be one of the reasons for companies or public regulators to introduce standards (Fulton and Giannakas, 2004; Gardner, 2003; Leland, 1979); b) studies on the role of standards in reducing consumption externalities (Besley and Ghatak, 2007; Copeland and Taylor, 1995); c) the role of standards in providing non-tariff trade protection (Anderson et al., 2004; Fischer and Serra, 2000; Otsuki et al., 2001); and d) the political economy of standards (Swinnen and Vandemoortele, 2008).

increasingly important role in world food markets and the growth of these vertically coordinated marketing channels is facilitated by increasing standards (Swinnen, 2007). For example, modern retailing companies increasingly dominate international and local markets in fruits and meats, including those in poorer countries, and have begun to set standards for food quality and safety in this sector wherever they are doing business (Dolan and Humphrey, 2000; Henson et al., 2000). Third, rising investment in processing and retailing in developing countries is translated into higher standards, as buyers are making new demands on local producers in order to serve the high-end income consumers or to minimize transaction costs in supply chains (Reardon et al., 2003).

Early studies argued that the penetration of international marketing chains was much more widespread than people originally thought (e.g., Gulati et al., 2007; World Bank, 2005) and predicted that the implications of these developments would be vast: a new development paradigm was emerging (Reardon and Timmer, 2005).

Importantly, the early literature also posited that the rise of standards could have sharp negative influences on equity and poverty. Several of the studies argued that modern supply chains in developing countries systematically exclude the poor and negatively affect the incomes of small farmers; unlike other waves of rising economic activity, the poor would suffer from this process (Farina and Reardon, 2000). For example, studies in Latin America and Africa argued that small farmers were being left behind in the supermarket-driven horticultural marketing and trade (Dolan and Humphrey, 2001; Humphrey et al., 2004; Key and Runsten, 1999; Reardon et al., 2003; Weatherspoon et al., 2001). In a study on Kenya, Minot and Ngigi (2004) demonstrated that modern marketing chains put intense pressure on smallholders (although smallholders were still participating). Even more extreme, in the case of Côte d’Ivoire, almost all of the fruits and vegetables being produced for exports were being cultivated on large industrial estates owned by wealthy capitalists. Likewise, Weatherspoon and Reardon (2003) reported that the rise of supermarkets in Southern Africa failed to help small producers who were almost completely excluded from dynamic urban markets due to quality and safety standards.

In contrast, recent research suggests a more nuanced picture of the effect of the international marketing chains on poverty and development. For example, Dries and Swinnen (2004) and Dries et al. (2009) find that high standards lead to increased vertical coordination in supply chains which improves access to credit, technology and quality inputs for poor farmers in Eastern Europe. Maertens and Swinnen (2009) and Minten et al. (2009) also find increased vertical coordination in newly emerging supply chains between buyers and farms in African countries, such as Madagascar and Senegal. According to their results, poor rural households experienced measurable gains from supplying high standards horticulture commodities to global retail chains. In China, researchers find that while rising urban incomes and the emergence of a relatively wealthy middle class are associated with an enormous rise in the demand for fruits and vegetables and sharp shifts in the downstream segment of the food chain towards ‘modern retailing’, almost all of the increased supply is being produced by small, relatively poor farmers that sell to small, relatively poor traders. (Huang et al., 2008; Wang et al., 2009)

An important shortcoming of this literature – in addition to empirical problems – is the absence of a consistent and comprehensive conceptual framework for interpreting the empirical findings. Related to this, very few of the empirical studies actually measure welfare or poverty effects. The vast majority of these studies analyze which farmers are supplying to the high standards market and/or the impacts on productivity or investments of supplying farms. The only studies that actually examine poverty effect are Maertens and Swinnen (2009) and Maertens et al. (2008). They find strong poverty reducing effects of high standards exports in Senegal. In addition, they show that much of the welfare benefits for the poor come through the labor market, which is ignored by most other studies. Moreover, no studies analyze other general equilibrium effects such as spillover effects on other markets.

The demand for integrating several markets into a single model leads to the use of general equilibrium as the most suitable tool (See, e.g., Mas-Colell et al. 1995, for a comparison between general and partial equilibrium.). The objective of this chapter is therefore to model the process through which high standards production and consumption affect development while explicitly taking into account general equilibrium effects and market imperfections. The model has both a low standards and high standards supply chain and we explicitly integrate key characteristics of many developing and emerging economies, such as capital constrains and labor market imperfections. We use the model to analyze how and through which channels welfare of rural and urban households is affected.

Because of many general equilibrium interactions the model is too complex to solve analytically. Therefore we use a computable general equilibrium model[22] and simulations to show the effects. For this, we calibrate the model with data from China. The development of high standards food sector in China is particularly relevant for three reasons. First, even though China has sustained high growth rates for nearly thirty years and the continuously increasing income per capita leads to structural change of Chinese diet (Gale and Huang, 2007), the food distribution system remained laggard until very recently. However, recent years are characterized by the fast rising supermarkets and some food safety scandals (Hu et al., 2004; Wang et al., 2009). Yet the transition from a system occupied mainly by low standards food produced by millions of small farms (Rozelle and Swinnen, 2004) to one

[22] As Shoven and Whalley (1992) have stated that 'The value of these computational general equilibrium models is that numerical simulations removes the need to work in small dimensions, and much more detail and complexity can be incorporated than in simple analytic models.' Of course, this merit does not come without costs. For example, CGE models are sensitive to certain major assumptions, to the choice of key parameter values, and to the calibration of the initial equilibrium data set (Shoven and Whalley, 1992). It is not our intention in the paper to predict the *size* of the impacts of high standards food, but rather show the mechanisms through which the expansion of the high standards food sector takes place and how it affects welfare, and which factors are crucially important to take into account. Considering the trade-off between complexities of out research questions and reliability of alternative methodologies, we think that CGE modeling is acceptable for our objective.

mainly by high standards food is only now starting and will undoubtedly have huge impact on both producers and consumers. Second, despite high growth rates, an increasing inequality between wealthy and poor households becomes a more and more acute issue (Ravallion, 2001). After the initially fast decrease of poverty rate, in the last decade China faces more difficulties in reducing the rural poverty (Chen and Ravallion, 2007; Riskin, 2004). 90% of poverty is still rural in China (World Bank, 2009). The welfare and poverty effects associated with the expansion of high standards food sector are therefore potentially very important. Third, in China, primary agriculture alone accounts for 12.5% of GDP in 2005 (CNBS, 2006), whilst the inclusion of food processing activities may push that statistic closer to 20%. Equally, Chinese primary agriculture employs around 44.8% of the workforce in 2005 (CNBS, 2006). Consequently, any ‘shocks’ which impact on the downstream food processing sectors have secondary economy-wide impacts. Fourth, both the agricultural commodity and factor markets are under transition. Whereas the commodity market is becoming more and more efficient (Huang and Rozelle, 2006), factor markets imperfections remain important. Therefore, China provides a very interesting case for research on the interaction between the food system transition and the acute equity and poverty problem under conditions of market imperfections.

3.2. Theoretical Framework

As discussed in the introduction, the findings of the previous literature suggest that the expansion of the high standards food affects the GDP growth and income distribution through various channels. Although, by focusing on a particular channel provides detailed insights of that particular channel, the partial equilibrium approach, which dominates the previous literature on food standards, has important drawbacks for interpreting the results and for drawing policy conclusions. In particular, it is essential to measure and integrate the impact on other commodity markets and on factor markets in order to fully capture the welfare effects.

In order to address the limitations associated with the partial equilibrium framework, the present chapter adopts a general equilibrium setting for studying the impacts of the expansion of the high standards food on household welfare. Our model follows the tradition of applied general equilibrium models pioneered by Shoven and Whalley (1992), although its precise specification is more closely allied to the CGE models described in de Janvry and Sadoulet (2002) and Stifel and Thorbecke (2003).

3.2.1. A Canonical Model

The structure of this type of models is as follows. The economy consists of N households indexed by *c*, M commodities indexed by *m* and J factors indexed by *j*. Let P be a vector of prices. The commodity demands can be derived from the first order conditions of household utility-maximization:

(11) $\max U^c$ s.t. $\sum p_m X^c = \sum p_j V^c$

where U^c is household utility, X^c and V^c denote commodity demand and factor endowment for the *c*th household, p_m and p_j are the corresponding commodity and factor prices.

Household demand for consumption goods is a function of their disposable income and the vector of consumer prices. Household incomes are determined by their ownership of production factors and returns to the production factors.

All the production technologies are typically based on nested constant elasticity of substitution (*CES*) functions with possible sub-nests in the form of *CES* or Cobb-Douglas (*CD*) functions.[23] The intermediate sectors produce goods according to a *CES* function of the

[23] CES and CD functions are used interchangeably in the literature to cater to research objectives and demand for data (Shoven and Whalley, 1992). And since rural and urban labor are nearly not substitutable, specifying technologies as Cobb-Douglas is reasonable in light of their characteristic zero cross-price elasticities of demand

rural labor, land and capital. Final food sectors produce goods by using a *CES* function to combine their respective intermediate products and the bundle of the basic factors (other than intermediate inputs), aggregated through a *CES* function with a sub-nest of a *CES* or *CD* function for the two types of labor. The gross output of the other commodities sector is a *CES* function with a sub-nest of a *CES* or *CD* function for labor.

Profit maximization behaviour yields factor demands

(12) $$V_j^m = V_j^m(p_j, Q^m)$$

The economy is connected to the rest of the world through trade. The substitutability between imported and domestic goods is determined on the consumption side through a CES aggregation function (Armington substitution function), and on the production side through a constant elasticity of transformation (CET) function. The relative prices of foreign goods are determined by world market prices and the exchange rate.

In order to model savings and investment, the following three assumptions are used: (1) savings are determined by exogenous constant rates for households; (2) private investment is savings driven; and (3) investment spending is allocated to commodities in fixed proportions.[24] For simplicity and data paucity, we further assume that only the final commodities are used as investment goods, while intermediate commodities not. Total savings equal total investments.

The total demand and supply of factors, goods and intermediate products must be equal in equilibrium. A general equilibrium for this model is given by a set of prices p^* and activity levels X^* such that demands equal supplies and no production activity makes positive profits

for inputs (Stifel and Thorbecke, 2003). Furthermore, if we assume CES technology for these two kinds of labor, it is difficult to determine the elasticity of substitution between them since there is few literature on this. Hence, we regard this assumption as acceptable considering both the reality and simplicity.

[24] Following Dewatripont and Michel (1987), this neoclassical closure is the most common one in comparative static CGE models and widely used in the literature (e.g., de Janvry and Sadoulet, 2002).

(13) $$Q^m = \sum X_m^c$$

(14) $$\prod^m (Q^m, p_m, p_j) = 0$$

The market for foreign exchange equilibrates via adjustments of the net export, with fixed trade surplus. Pressures to adjust export or import quantities (and hence, demand and supply of foreign currency) are therefore equilibrated by adjustments in the foreign exchange rates.[25]

The aggregate consumer price index (*CPI*) and the aggregate producer price index (*PPI*) are defined as sum of composite prices (PQ_m) weighted by the value shares of final goods (ν_m) and the sum of producer prices (PI_m) weighted by the value shares of output (μ_m), respectively.

(15) $$CPI = \sum_m \nu_m * PQ_m$$

(16) $$PPI = \sum_m \mu_m * PI_m$$

The nominal exchange rate is used as a numeraire (de Janvry and Sadoulet, 2002). This ensures that only the relative prices matter.[26]

Household welfare (W^c) is measured by real income, which is nominal income (Y^c) normalized by a household-specific price index (P^c):

(17) $$W^c = \frac{Y^c}{P^c}$$

To measure inequality a Gini coefficient can be calculated through the trapezium rule:[27]

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[25] This assumption has no important impact on results. In fact, if savings do not enter households' utility function, then fixing either the exchange rate or the trade balance is the same right approach for welfare analysis, since it prevents an arbitrary shift away from savings towards current consumption from being confused with a welfare improvement. And in our model, we will fix the exchange rate as numeraire so that our modelling is compatible to the case of China, where exchange rates are not quite flexible.

[26] As stated by de Janvry and Sadoulet (2002), the choice of numeraire has no impact on real income effects, but has impact on decomposition of real income effects, which should be born in mind to explain the simulation results.

(18) $$G = 1 - \sum_{c=1}^{n} (N^c - N^{c-1}) * (Y^c - Y^{c-1}), c \in C$$

where N^c and Y^c are the cumulated proportions of population and income respectively.

3.2.2. Extensions to Include Market Imperfections in the Literature

The first seminal paper on CGE with imperfect competition is Harris (1984), which introduces the concepts of imperfect competition, economies of scale, and entry and exit, etc. into the empirical research field of applied general equilibrium models and checks whether these concepts have some different impacts from models with perfect competition based on the same dataset. He finds that the results are significantly different and hence proved the importance of taking account into imperfect competition in CGE models.

After him, a lot of papers also build similar CGE models to check whether imperfect competition shows some difference from perfect competition (e.g., Devarajan and Rodrik, 1989; Francois and Roland-Holst, 1997). Willenbockel (2004) checks the robustness of different specifications and get the result that 'simulation results are generally far more sensitive to numerical specification choices at the calibration stage, than to the prior choice of firm conduct specification'. To apply these models suitably, others also check whether there is unique solution under such assumptions (Mercenier, 1995).

All the above models are trying to analyze the effects of trade liberalization based on the conjecture that trade liberalization is pro-competitive which can't be captured by the models with perfect competition. Hence their policy simulations focus on reduction of tariff or remove of non-tariff barriers. Konan and van Assche (2007) have a more innovative

[27] For this we make use of the trapezium rule which is an approximate technique for calculating the definite integral of Gini coefficient. In our case, the trapezium rule is applicable since the income distribution of representative households is not continuous (Cruz-Uribe and Neugebauer, 2002).

strategy. To estimate the impact of telecom liberalization in Tunisia, they just analyze the effect of allowing a single foreign provider to enter Tunisia's telecom market.

To account for firm heterogeneity and following Melitz's (2003) theoretic innovation, Zhai (2008) integrates firm heterogeneity into CGE models and finds that model results are sensitive to parameters of firm productivity distribution. His model is also rich in including continuous distribution of product varieties.

Even though there is already a vast literature on CGE models with market imperfections, the application of this kind of models to agriculture is limited. Since agricultural sector is full of market imperfections (de Janvry et al., 1993), a CGE model with market imperfections is suitable to explain the paradoxes in this field.

3.2.3. Integrating Standards and Market Imperfections

In order to incorporate the key features of food standards and their linkages to the rest of the economy, we extend the canonical CGE model along several dimensions. First, given that differentiated goods are important for studying the impact of standard expansion, we extend the canonical CGE model by introducing two types of vertically differentiated goods in the food sector (Vandemoortele et al., 2009):[28] low standards food and high standards food. Second, to allow for differential effects among rural households we explicitly model heterogeneity of farmers (de Janvry and Sadoulet, 2002). Third, in order to study the impact of rural credit market imperfections, which are very important in many developing countries, we introduce credit constraint for rural households, different from Harris (1984) which assumes monopolistic competition. Finally, in order to trace rural-urban effects of the high standards food expansion, an inter-regional CGE approach of Kilkenny (1993), Ando and

[28] The same extensions can be straightforwardly implemented also to other sectors. However, for the sake of simplicity, these extensions are not presented here.

Takanori (1997), and Kancs (2001) is adopted with labor market imperfections. Figure 3.1 and Table A3.1 summarize the model structure.

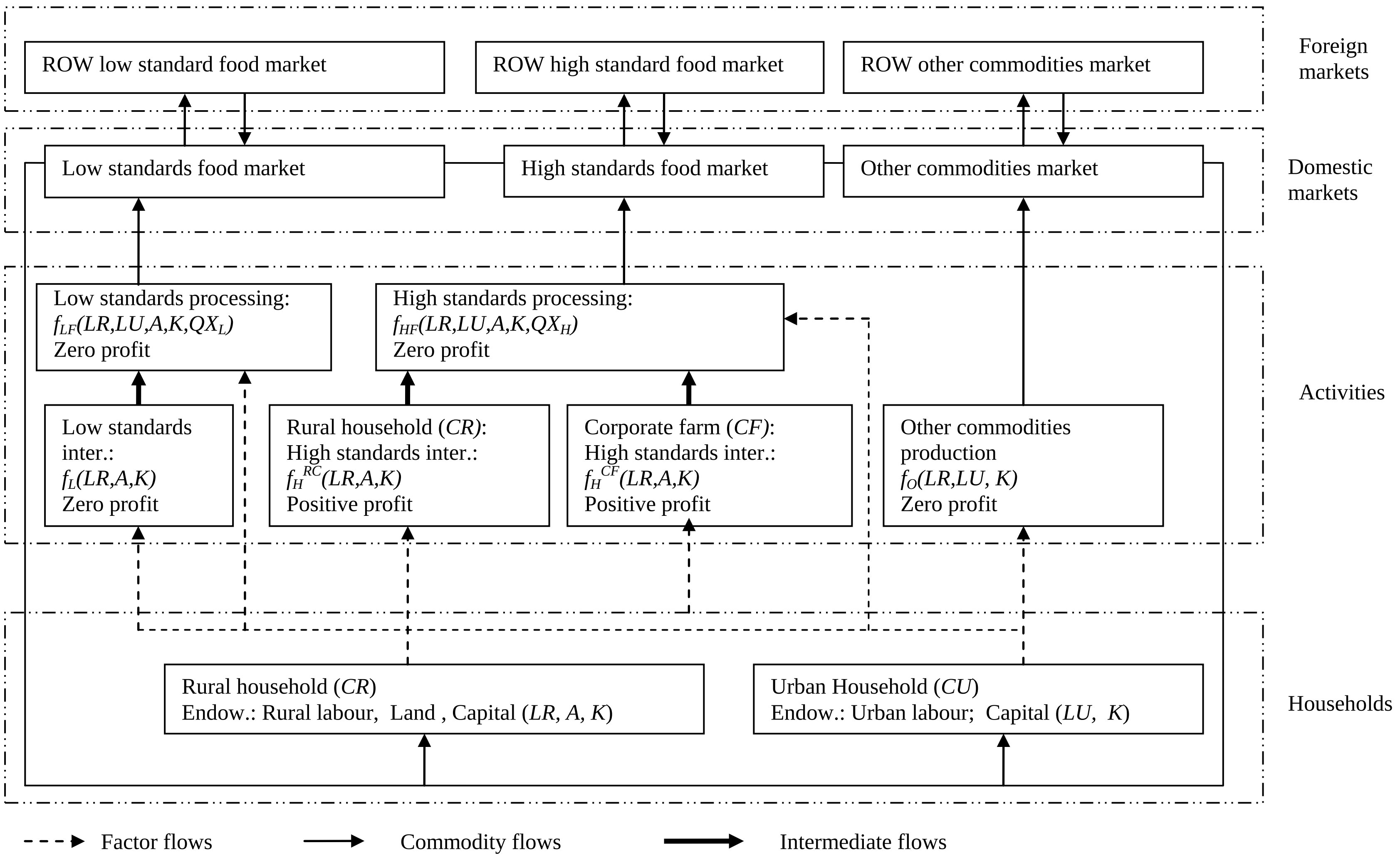
Accounting for the dual farm structure characteristic to many developing countries, there are two types of rural producers in the model: households (*C*) (which will be further separated in different groups in the calibration and simulations) and corporate farms (*CF*).[29] On the consumer side, in order to study the distributional consequences of standards, we distinguish between urban and rural households, and rural households are further disaggregated into several income groups. There are four types of factor inputs: rural labor (LR), urban labor (LU), capital (K) and land (A), with rural households (*CR*) owning three types of them: rural labor, land and capital, while urban households (*CU*) owning urban labor and capital. The detailed modeling of different types of rural producers and consumers allows us to decompose the aggregate income effects of the high standards food expansion, which are crucial for policy recommendations

Five commodities are produced in the economy, three of which are final goods: low standards food (*LF*) and high standards food (*HF*) and other commodities (*O*).[30] There are two types of agricultural intermediate products: low standards (*L*) and high standards (*H*), which are located in the rural areas and exclusively used by their respective food processing sectors, which take place in both the rural and urban areas, to produce the respective final food. Given that the main focus of the chapter is on food standards, we do not include

[29] To avoid confusion between notations for households and high standards, we use capital '*C*' and '*H*' to indicate households and high standards respectively. Later, to differentiate with activity set, noted as '*I*', we use '*O*' as the notation for the industrial sector. We use '*LF*'/'*HF*' and '*L*'/'*H*' for low/high standards final food and low/high standards intermediate products respectively.

[30] The underlying model is not limited to the selected five sectors, it can be straightforwardly expanded to *n* sectors. However, given that they would add little insights to our question, while unnecessary complicating the analysis, the rest of the economic activities are aggregated into one sector 'other commodities'.

Figure 3.1 Model Structure



intermediate goods in other sectors.[31]

We assume that high standards food is a luxury good compared to low standards food products. Accordingly, household consumption is modelled by the following system:[32, 33]

$$X_{HF}{}^{c} = \frac{a_{HF}^{c}(1-mps^{c})Y^{c}}{PQ_{LF}} - a_{LF}^{c}\zeta^{c}, c \in C$$

(19)
$$X_{LF}{}^{c} = \frac{a_{LF}^{c}(1-mps^{c})Y^{c}}{PQ_{LF}} + \frac{PQ_{HF}}{PQ_{LF}} a_{LF}^{c}\zeta^{c}, c \in C$$

$$X_{O}{}^{c} = \frac{(1-a_{LF}^{c}-a_{HF}^{c})}{PQ_{O}}(1-mps^{c})Y^{c}, c \in C$$

subject to the household budget constraint:

$$\sum_{m} P_m X_m^c = (1-mps^c)Y^c, c \in C$$

where a_m^c is the commodity share parameter in the household consumption function, mps^c the saving rate for households and ζ^c a parameter determining the degree of preference for low standards food. A smaller ζ^c means a larger preference for high standards food.

Factor use in the production of these commodities will be affected by specific investment requirements and market imperfections. In order to produce high standards intermediate product, farms face some fixed investment costs to satisfy the standards requirement (Farina and Reardon, 2000; Maertens and Swinnen, 2009). Following Harris (1984) and without loss of generality, we assume that these fixed investment costs are a

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[31] Theoretically, this assumption might have implications for the income of rural and urban households. For example, in the presence of inter-regional trade costs and input-output linkages, firms located in the larger region would have access to cheaper intermediates and hence could pay higher wages to factors (Krugman and Venables, 1995). Considering the additional complexity which would be brought about by incorporating this effect, as well as the data paucity, we have decided to ignore this effect. This is a standard assumption in this type of models (e.g. de Franco and Godoy, 1993; de Janvry and Sadoulet, 2002; Gelan, 2007; Stifel and Thorbecke, 2003).

[32] This is a modified Linear Expenditure System derived from Stone-Geary utility function (Stone, 1954). 'This demand system has the advantage of specifying non-discretionary and discretionary expenditure.' (Savard, 2005)

[33] We only cite the most critical equations in our model while keep the set of all equations in Table A3.1.

mixture of rural labor (φ) and capital (ψ). In the simulations later we will analyze the effect of assumptions on fixed costs.

Rural households are often credit constrained (see e.g., Barham et al., 1996; Swinnen and Gow, 1999). We assume that, because of rural credit market imperfections, rural households and corporate farms face credit constraints in their production for the high standards intermediate product market. To model this we assume that the supply of capital in the high standards intermediate sector (K_H^c) for the engaging households and corporate farms are constrained as follows:

(20) $$K_H^c = \kappa^c r^{\varepsilon^c}, c \in CR \bigcup CF$$

where κ^c is the collateral,[34] r the price of capital, and ε^c the capital supply elasticity.

To model the labor market, we use stylized facts from a 'typical' developing economy. Net wages of workers in rural region are generally lower than wages of workers in urban region, even when rural workers migrate to urban areas. This can be explained by different skills of different labor types or by transaction costs of migration (Stifel and Thorbecke, 2003). To account for this, we model the labor market as two separate sub-markets with different skill labor (rural and urban labor), and migrating from rural to urban region is subject to iceberg transaction costs, τ, with $0 < \tau < 1$. Thus, $wr_U = wr_R / \tau$, where wr_U and wr_R are the wages for rural workers working in urban and rural regions respectively. Finally, as usual in CGE modeling, we assume that leisure is not an argument of the worker's utility function so that labor is supplied inelastically.

All sectors have zero profit as in the canonical CGE model except the high standards intermediate sector, where rural households and corporate farms may earn positive profits if credit constraints limit their production capacity to satisfy the market. This reflects the

[34] Calibration of the collateral κ^c is realized by setting the capital supply elasticity ε^c.

investment costs of high standards production, which may be prohibitive for poor rural households (Hallward-Driemeier et al., 2003).

More specifically, rural households and corporate farms' profits ($\prod^c$) in high standards intermediate sector are given by the value-added net of factors payments:

(21) $$\prod^c = PX_H f_H(LR_H^c, A_H^c, K_H^c) - wr_R(LR_H^c + \varphi^c) - tA_H^c - r(K_H^c + \psi^c), c \in CR \bigcup CF$$

Profits of corporate farms are transferred to involved factors proportionally according to their value shares in production.[35] Since the rural households use mostly their own factors, the profits from their high standards farming stay with them. Hence, rural households' net income (Y^c) is therefore the sum of its profit in high standards farming, factor incomes and profit sharing from corporate farms while the urban households' income is only composed of factor incomes and profit sharing:

(22) $$Y^c = \begin{cases} wr_R LR^c + tA^c + rK^c + \prod^c + \gamma^c \prod^{CF}, & c \in CR \\ wuLU^c + rK^c + \gamma^c \prod^{CF}, & c \in CU \end{cases}$$

where γ^c is the endogenous share parameter of transferred profit from corporate farms.

Finally, we adjust the standard assumption on tradability. We assume a partially open economy, i.e., all final goods are traded with the rest of the world (ROW) while intermediate goods and factors are internationally immobile. For simplicity, we do not include government and taxes in the model.

This model will allow to trace the impacts of the high standards food expansion on rural and urban household income taking into account essential characteristics. It will also allow to measure the impact on the share of rural households supplying low standards food intermediates and high standards food intermediates and on the share of rural workers

[35] This assumption is general and can be easily modified to suit specific cases. It is widely used in the literature (e.g., Rodrik, 1998; Stifel and Thorbecke, 2003). The actual distribution of profits among factors depends on the bargaining power of factor owners (Swinnen and Vandeplas, 2007). In fact, because the profit is not a big amount comparing with the overall factor incomes, our assumption will have no significant impact on the empirical results.

working in own farm versus in corporate farms. In addition, it allows us to disaggregate the total income effects into several components, including a profit effect and income effects of specific factors. By including different types of rural households in our model we can draw implications on poverty and inequality.

3.3. Empirical Implementation

We calibrate the CGE model of Chapter 3 to data from China for 2005 (see Appendix A for details). As usual in CGE models, the data base is organized in the form of a Social Accounting Matrix (SAM), which is shown in Table 3.1. The CGE model is operationalised using the General Algebraic Modelling System (GAMS) software (Brooke et al., 1988).[36] The model is calibrated so as to reproduce the macroeconomic benchmark data from the SAM.

The structure of the model allows us to isolate the effects on urban and rural households. In addition, we separate 'rural households' into two groups by their income level: 'the poorest' and 'the other' rural households. We define 'the poorest' and 'the other' rural households according to the stratification by the national statistics bureau. The households quintile with lowest income in the national statistical data is regarded as 'the poorest' rural households. The other four quintiles with higher income are grouped together to represent the other rural households. Hence, the share of the poorest rural households in the whole population is 11.4%. In the base year the poorest rural households had an average income per capita of 2090.02 Yuan while the other rural households 5677.81 Yuan. Table 3.2 shows summary statistics of the income structures of households.

[36] The source code is available from the authors upon request.

Table 3.1 Archetype SAM of China When the Same Technology Is Used in High Standards and Low Standards Farming
(Unit: 100 million Yuan)

	Low inter.	High poorest	High other	High corp.	Low proc.	High proc.	Other com.	Rural labor	Urban labor	Land	Capital	LaborRCFP	LandCFP	Capital CFP	CFP	High inter.	Poorest rural	Other rural	Urban	S-I	ROW
Low inter.					23104.2																
High poorest																14.0					
High other																207.7					
High corp.																11.7					
Low proc.																	1933.7	14358.2	12512.8	2227.7	1416.8
High proc.																	3.0	40.4	242.5	119.3	176.0
Other com.																	2163.2	25835.2	36797.7	77173.0	42412.5
Rural labor	10514.2	5.7	83.9	4.7	1359.1	13.7	29105.5														
Urban labor					2365.2	40.9	82926.2														
Land	4362.9	2.3	34.8	2.0	1523.3	15.4															
Capital	8227.2	4.4	65.7	3.7	2876.9	29.1	40037.2														
LaborRCFP															0.6						
LandCFP															0.2						
CapitalCFP															0.5						
CFP				1.3																	
High inter.						233.4															
Poorest rural		1.6						3727.5		370.7		0.05	0.02								
Other rural			23.3					37359.3		5570.1	18471.8	0.5	0.2	0.2							
Urban									85332.2		32772.4			0.3							
S-I																	0.0	21191.4	68551.6		
ROW					1220.8	248.9	32312.7													10223.0	
Total	23104.2	14.0	207.7	11.7	32449.5	581.3	184381.6	41086.8	85332.2	5940.8	51244.2	0.6	0.2	0.5	1.3	233.4	4099.9	61425.3	118104.6	89743.0	44005.3

Source: Authors' calculation based on China's yearbooks and input/output table. Without extra indication, sources are from authors' calculation

Table 3.2 Source of Household Income (%)

	Rural labor	Urban labor	Land	Capital	Profit	Total
Poorest rural	90.92		9.04		0.04	100.0
Other rural	60.82		9.07	30.07	0.04	100.0
Urban		72.25		27.75	0.00	100.0

Source: Based on SAM in Table 3.1.

A crucial issue is how to identify 'high standards' commodities in the baseline because there are no precise data since this is just an emerging sector in China. We considered several options and indicators, but none are satisfactory since there are effectively non representative data on high standards production and consumption. For example, Hu et al (2004) estimated that roughly 30% of food was sold through supermarkets. The large wholesale and retail companies defined by Chinese Economic Yearbook (CEYC, 2006) sold 8.7% of total food. However, Wang et al. (2009) showed that nearly all of this produce came through semi-traditional supply channels and production systems. For this reason, and based on expert judgements indicating that high standards production is still minimal and not particularly linked with specific commodities, we make the working assumption that 5% of all commodities were 'high standards', and we used this share consistently across production systems, investment activities, etc. for the baseline model. Using a rather small share (5%) assumption implies that the size of the effects will be small. However, this is less of a problem since in this exercise we are primarily interested in the direction and the relative size of different sub-effects. Furthermore, in simulations and sensitivity analyzes, we analyze how variation in investment costs, production technologies, elasticities etc. in the high standards sector affect the growth scenario effects.

The calibration involves the determination of all parameters and elasticities and processes.[37] This calibration involves several steps. First, measurement units for factor categories are chosen such that all commodity prices and factor prices, except the wage of the unskilled rural laborer who is working in urban region, are initially equal to unity.[38] Similarly, measurement units for domestic commodities, imports and exports are chosen such that consumer prices and the exchange rate are equal to one in the base year. With these normalizations, all initial quantities and remaining prices can be computed. These steps also allow the computation of the parameters (which are directly computed from these values). Other initial quantities, such as the distributional shares of labor income, land income, capital income, profit and investment, reflect the values observed in the data base.

Second, elasticities are drawn from the relevant literature.[39] Notice that the choice of all elasticities will be subject to sensitivity analysis (Appendix B). Table 3.3 summarizes elasticities applied in our model. Specifically, the income elasticities of low standards products are 0.9, 0.4 and 0.1 for the poorest and the other rural households, and urban households respectively. Such a structure is compatible with the literature and the stylized

Table 3.3 Parameters Applied in the Model

	Intermediate product	Final food	Other commodities
Elasticity of factor substitution	0.7	0.15 (Agg.); 0.8 (Sub-nest)	0.9
Armington elasticity of substitution	-	3.0	0.5
Elasticities of transformation	-	1.2	0.8
	Poorest rural	Other rural	Urban
Income elasticity of low standards food	0.9	0.4	0.1
	Poorest-high	Other-high	Corporate farms
Price elasticities of capital supply	0.7	1.3	1.9

[37] Because of abundance of parameters and meaninglessness of absolute values, we do not provide a complete set of all parameters. This kind of presentation method is widely accepted in the literature, e.g., Konan and van Assche (2007).
[38] This is a standard treatment in computable general equilibrium models and will have no impact on the results since the model is homogenous of degree zero (Shoven and Whalley, 1992).
[39] For a review of literature on elasticities, see Ciaian et al., 2002.

facts that poor households consume a relatively larger share of staple (low standards) food compared to wealthy households (Lipton, 2001). On the import side, a relatively low aggregation elasticity between imports and domestic consumption goods is assumed (elasticity of 0.5) for the other commodities sector, which reflects product differentiation between the domestically produced commodities and imports of these large aggregates. For the food sectors, including both low and high standards food, we assume a rather high elasticity of substitution (3.0). In addition, on the export side, the level of elasticities of transformation depends on the homogeneity of the aggregated sectors (Shoven and Whalley, 1992). Given the large sectoral aggregations in our study, we assume intermediate values (1.2) for both low and high standards food sectors, and lower value (0.8) for the other commodities sector.

Finally, all production functions are *CES* in the top nests, with a medium value of substitutability among these factors equal to 0.7, 0.15 and 0.9 for intermediate, processing and the other commodities sectors, respectively. The choice of relatively small elasticities of substitution between intermediate input and other factors is standard and caters to the reality (e.g., Wang and Schuh, 2002). The elasticity of substitution among basic factors in the sub-nest *CES* of the processing sectors is equal to 0.8. The price elasticities of variable capital supply for the high standards intermediate activities of rural households and corporate farms are set rather moderately (0.7, 1.3 and 1.9 for the poorest and the other rural households, and corporate farms respectively).

3.4. Simulations

3.4.1. General Approach

A problem in simulating the expansion of high standards food production is that the size of the high standards food sector cannot be changed exogenously in the model. In our

CGE framework supply and demand of all commodities, including high standards intermediary and final products are endogenously determined. Therefore we 'induce' the expansion of the high standards food sector in different ways. First, we simulate an increase in the world price of high standards products (which is exogenous) – a scenario which we refer to as 'export-led growth'. An important factor is the elasticity of transformation of high standards food, i.e., the elasticity of substitution between domestic and exported product. Therefore we simulate export-led expansion when the elasticity of transformation is 'normal' (i.e., as in other models) and when it is high (simulations 1A and 1B). Second, we simulate an increase in (domestic) consumer preferences for high standards food. This scenario we refer to as 'domestic demand growth'. As will become clear from the simulations, growth in consumer demand induces import growth of high standards food with open trade. Therefore we analyze the domestic demand growth scenario with elastic imports (simulation 2A) and inelastic imports (simulation 2B).

A crucial issue in the simulations is the assumption on the technology used by the high standards sector in China. As explained above, there are no precise data on the emerging high standards sector because it is just an emerging sector in China and there is no consensus whether high standards farming in general is relatively labor- or capital-intensive compared with other activities (Bijman, 2008; Miyata et al., 2009; Weinberger and Lumpkin, 2007). Therefore we construct a baseline SAM and perform simulations by assuming the same production technology, i.e. factor intensities, in high standards and low standards farming.[40] Later, we simulate how different production technologies in high standards farming affect the results.[41] The actual production structures for each scenario (sets of assumptions) can be

[40] In the initial simulations with the same factor intensities for low and high standards, we use the weighted average of the factor shares for all agricultural commodities in China.

[41] When constructing the SAM under assumption that high standards farming is relatively labor (capital) intensive, we change labor and capital use in the other commodities sector, so that the SAM keeps its balance.

found in Table 3.1. Next, we study the effect of market imperfections. In particular we simulate how the impacts change when credit market constraints are more or less binding.

In addition to these simulations, in order to assess the robustness of our results we performed sensitivity analysis of the key assumptions on income elasticities of low standards products, the elasticities of transformation and substitution in the Armington equations and the substitution elasticities in production. The results, some of which are presented in Appendix B, show that our key conclusions are robust to variations in all these parameters.

3.4.2. Scenario 1: Export-led Growth in High Standards

China has continuously increased its exports of agricultural products and the ratio of agricultural trade to agricultural GDP has risen steadily (Huang et al., 2000). According to Gulati et al. (2007), an outward-looking trade policy can induce the growth of high quality products. The main mechanism for this rise of high standards products is that traders are forced to meet international standards and safety regulations. These standards are typically considerably higher than in developing countries, such as China.

To study the potential impact of this export-led emergence of high standard farming, we exogenously increase the world market price for high standard products, pwe_{HF} and pwm_{HF}, by 25%. The simulation results for the effect of rising international prices of high standard commodities are reported in the first column of Table 3.4. As a consequence of the increase in the world market price of HS products, the domestic consumption of HS declines (-59%) strongly and that of LS products increases (+0.61%). There is a decline in imports (-78%) and growth of exports (+31%) of HS products. There is a rise in the domestic price of HS products (+1.64%) and corresponding increase in production of both HS products (+9.31%) and LS products (+0.48%) because growth in the international demand for HS products and growth in the domestic demand for LS products leads to increased production of

Table 3.4 Simulation Results: The Same Technology in High Standards and Low Standards Farming
(Percentage change comparing with baseline)

Sim 1A: World price of high standards food increases by 25% ($\Delta pwe_{HF} / pwe_{HF} = +25\%$, $\Delta pwm_{HF} / pwm_{HF} = +25\%$); Elasticity of transformation of high standards food is normal ($\sigma_{HF}{}^{t} = 1.2$).

Sim 1B: World price of high standards food increases by 25% ($\Delta pwe_{HF} / pwe_{HF} = +25\%$, $\Delta pwm_{HF} / pwm_{HF} = +25\%$); Elasticity of transformation of high standards food is large ($\sigma_{HF}{}^{t} = 20$).

Sim 2A: Urban households' preference for low standards food decreases by 25% ($\Delta \zeta^{U} / \zeta^{U} = -25\%$); Import is elastic ($\sigma_{HF}{}^{q} = 3$).

Sim 2B: Urban households' preference for low standards food decreases by 25% ($\Delta \zeta^{U} / \zeta^{U} = -25\%$); Import is inelastic ($\sigma_{HF}{}^{q} = 0.1$).

	Sim 1A	Sim 1B	Sim 2A	Sim 2B
Aggregate effects				
Real GDP	-0.05	-0.07	0.16	0.03
CPI	0.48	0.95	-1.09	-0.17
Gini coefficient	-0.28	-0.57	0.51	0.02
Real Gini coefficient	-0.25	-0.53	0.40	-0.04
Consumptions				
Low standards food	0.61	1.03	-2.19	-0.73
High standards food	-58.58	-99.95	178.22	50.38
Other commodities	0.05	0.11	-0.07	0.01
Output of final commodities				
Low standards food	0.48	0.79	-1.91	-0.68
High standards food	9.31	25.79	24.29	24.66
Other commodities	-0.12	-0.22	0.33	0.08
Individual output of high standards intermediate product				
Poorest rural households	7.58	20.93	20.75	20.59
Other rural households	8.95	24.71	23.19	23.58
Corporate farms	9.06	24.83	21.84	22.88
Trade				
Import volume				
Low standards food	2.65	5.08	-6.84	-1.68
High standards food	-77.73	-99.97	274.11	52.23
Other commodities	0.25	0.50	-0.52	-0.08
Export volume				
Low standards food	-0.32	-0.76	0.01	-0.30
High standards food	31.24	130.48	0.96	0.45
Other commodities	-0.41	-0.80	1.01	0.21
Rural labor used in high standards intermediate product				
Poorest rural households	14.74	44.23	38.89	43.83
Other rural households	16.21	48.73	45.35	47.40
Corporate farms	15.42	46.82	43.07	46.56
Domestic consumer price				
Low standards food	0.67	1.31	-1.61	-0.32
High standards food	1.64	2.97	10.37	14.55
Other commodities	0.39	0.78	-0.90	-0.17
Company food price				
Low standards food	0.67	1.31	-1.60	-0.32

High standards food	7.33	21.27	18.92	19.72
Other commodities	0.37	0.73	-0.84	-0.16
Farm gate price				
Low standards intermediate product	0.69	1.35	-1.65	-0.33
High standards intermediate product	10.23	30.00	27.67	28.35
Factor price				
Rural labor	0.54	1.07	-1.22	-0.22
Urban labor	0.27	0.55	-0.56	-0.08
Land	1.52	2.96	-3.63	-0.71
Capital	0.44	0.85	-1.14	-0.27
Poorest rural households				
Profit effect from high standards farming	0.03	0.10	0.11	0.11
Profit sharing from corporate farm	0.00	0.00	0.01	0.01
Factor income effect	0.10	0.20	-0.21	-0.03
Among it:				
Labor	0.01	0.03	0.01	0.01
Land	0.09	0.17	-0.22	-0.04
Total income effect	0.14	0.31	-0.09	0.08
Other rural households				
Profit effect from high standards farming	0.03	0.10	0.11	0.11
Profit sharing from corporate farm	0.00	0.00	0.00	0.00
Factor income effect	0.10	0.20	-0.27	-0.07
Among it:				
Labor	0.03	0.05	-0.05	-0.00
Land	0.09	0.17	-0.23	-0.05
Capital	-0.02	-0.03	0.00	-0.02
Total income effect	0.14	0.31	-0.16	0.05
Urban households				
Profit sharing from corporate farm	0.00	0.00	0.00	0.00
Factor income effect	-0.15	-0.28	0.31	-0.00
Among it:				
Labor	-0.14	-0.26	0.34	0.04
Capital	-0.01	-0.02	-0.03	-0.04
Total income effect	-0.15	-0.28	0.31	0.00

both. Labor use increases substantially on all farms (around 15%) and returns to all rural production factors increase: between 0.44% (capital) and 1.52% (land). As a consequence, rural household incomes increase by 0.14% (for both poorest and other households). Urban households lose (-0.15%) as their increased wages from increased employment in HS food processing are more than offset by increased consumer prices. Notice that the income effects are small. The main reason is that the HS sector is small and changes there have relatively limited effects on aggregate. Therefore, what is most important here – if one assumes that the sector will grow in the future and thus that the size of the effects will become larger – is the relative size of the effects.

However, another reason is relatively limited ‘pass-through’ of world market effects on the domestic market. A comparison with simulation 1B shows that these effects are strongly depending on the elasticity of transformation between domestic and exported products. With a higher elasticity, the increase in prices is much larger: the price of domestic HS food is higher (+2.97%) instead of +1.64% as in the increase in the (farm gate) price of HS intermediate goods (+30% instead of +10%). The output response is stronger both for HS food (+26% instead of +9%) and HS farm products (more than 20% compared to less than 10% on all farms). Labor use on farms increase much more (by more than 40%) and the income effects for rural households are more than double: +0.31% compared to +0.14%.

3.4.3. Scenario 2: Domestic Demand Growth in High Standards

Simulation 2A models the effect of a growth in domestic preferences for HS food. These effects are quite different. Now the substitution between LS and HS food leads to an increase in HS food consumption (+178%) but a decline in LS food consumption (-2%). However these changes have important implications because most of this increased consumption comes from increased imports of HS food (+274%). Domestic production of HS food (+24%) and HS intermediate products (+21% to +23%) increase less, while LS production falls. Because of the importance of LS production, this leads to a decline for all rural factor returns: labor (-1.22%), land (-3.63%) and capital (-1.14%). All rural households lose because of this, but the poorest lose less because they own less land and because they consume more LS food. Since LS food prices go down, they benefit as consumers. Notice that the household income numbers in Table 3.4 reflect real income effects and that we use household-specific *CPI*s to measure these. For example, while the factor price of rural labor declines by 1.22% in simulation 2A, the factor income from labor for the poorest household increases by 0.01% because their *CPI* decrease by more than the labor price, as LS food prices (which make up a large share of their expenditures) decline by 1.61%. This is less the case for richer households which spend more on HS food whose price increases by more than 10%.

Again these results are strongly influenced by the trade effects. In simulations 2B we consider the same exogenous change in preferences but with less elastic imports. In this case domestic producers benefit more from the increased demand for HS food by domestic consumers. In fact, the increased profits from the production of intermediate products for HS food more than offset losses from declining prices for LS products. Now rural households benefit: their incomes increase slightly: by 0.05% to 0.08%. However in this case urban households benefit less from imported HS food. The increase in domestic HS food prices is higher (+15% compared to +10%) and the reduction of LS food price lower (-0.32% compared to -1.60%). Their net income effects are zero (compared to +0.31%).

3.4.4. Aggregate Effects

Before turning to some sensitivity analyses let us also briefly consider the overall effects. In the export-led scenario both real GDP (by -0.05% to -0.07%) and inequality decline (Gini declines by -0.28% to -0.57%). The reason of GDP reduction is that China is a net importer of high standards food. With increasing prices for high standards products, the negative effect on consumers is larger than the positive effect on producers at the level of the country. Hence, the growth in rural incomes with increase international HS prices is more than offset by urban consumers' losses in terms of total growth, but it does lead to a reduction in inequality. The aggregated effects of the domestic growth scenario depend on the trade effects. With elastic trade responses, the growth in urban household income more than offset declines of rural incomes. Hence there is aggregate growth (+0.16%) but inequality increases (Gini +0.51%). With inelastic imports, there is still growth but now the Gini coefficient goes up (+0.02%) indicating induced inequality. At first sight, this is surprising since (poorest) rural household incomes increase and (richer) urban household income does not change. The reason is that the Gini coefficient is calculated in nominal terms or, equivalently, using the same *CPI* for all households. We have therefore also calculated a 'real Gini' coefficient which uses household-specific *CPI*s, to capture different consumer effect. As Table 3.4 shows, the real Gini is negative (-0.04%), showing a reduction in inequality, which reflects the real income changes more correctly.

3.4.5. Additional Comparisons Between the Two Scenarios

To further analyze the difference between the export-led and the domestic demand growth scenarios, we compare the two scenarios under the specific conditions that they induce the same increase in the relative price of high standards food compared to low standards, first at the domestic market and next at their respective consumer markets.[42]

In Table 3.5, the comparison is based on (approximately) the same relative domestic consumer price increase of 1.20%. The first two columns report the results when import is elastic. The last two columns report the results when import is inelastic. Notice that due to the substitution and transformation in the CGE model and the small size of the HS sector in consumption and production, the change of 1.2% of relative consumer prices requires a large change in world market prices for HS (46% and 70% respectively), and a more modest change in urban household preference (2.3% to 2.5%).

The most important insight is that export-led growth has a more significant impact on real incomes of rural households. For example, when import is elastic, the same relative consumer price increase will lead to income increases by 0.42% and 0.40% for the poorest and other rural households respectively in the scenario of export-led growth, while it will

[42] Relative price increase=(Price of high standards food/Price of low standards food-1)*100

hardly affect rural households income (0.00% and 0.01% change) in the scenario of domestic demand growth. The Gini coefficients also reflect this. In both scenarios, the poorest rural households can gain the production of HS (also through its impact on factor markets), but the impact from factor markets, poorest rural households lose a little in the scenario of domestic demand growth in total because they lose with a decline in the demand for low standards production and its price. Nonetheless, they gain a lot from the factor markets (+0.20%) in the scenario of export-led growth.

Table 3.5 Comparing Export-led Growth and Domestic Demand Growth
(Percentage change comparing with baseline)

Sim 5A: World price of high standards food increases by 70% ($\Delta pwe_{HF} / pwe_{HF} = +70\%$, $\Delta pwm_{HF} / pwm_{HF} = +70\%$); Import is elastic ($\sigma_{HF}{}^{q} = 3$).
Sim 6A: Urban households' preference for low standards food decreases by 2.5% ($\Delta\zeta^{U} / \zeta^{U} = -2.5\%$); Import is elastic ($\sigma_{HF}{}^{q} = 3$).
Sim 5B: World price of high standards food increases by 46% ($\Delta pwe_{HF} / pwe_{HF} = +46\%$, $\Delta pwm_{HF} / pwm_{HF} = +46\%$); Import is inelastic ($\sigma_{HF}{}^{q} = 0.1$).
Sim 6B: Urban households' preference for low standards food decreases by 2.3% ($\Delta\zeta^{U} / \zeta^{U} = -2.3\%$); Import is inelastic ($\sigma_{HF}{}^{q} = 0.1$).

	Sim 5A	Sim 6A	Sim 5B	Sim 6B
Aggregate effects				
Real GDP	-0.05	0.01	-0.06	0.00
CPI	0.99	-0.05	0.64	-0.01
Gini coefficient	-0.66	0.02	-0.37	0.00
Real Gini coefficient	-0.61	0.02	-0.34	-0.00
Relative price increase*	1.20	1.23	1.20	1.22
Consumptions				
Low standards food	0.61	-0.11	0.65	-0.05
High standards food	-33.56	3.96	-70.08	3.96
Other commodities	0.02	0.00	-0.01	0.00
Output of final commodities				
Low standards food	0.54	-0.10	0.60	-0.05
High standards food	40.37	2.02	14.32	2.00
Other commodities	-0.21	0.02	-0.16	0.01
Individual output of high standards intermediate product				
Poorest rural households	32.75	1.72	11.66	1.69
Other rural households	38.55	1.94	13.75	1.93
Corporate farms	38.42	1.86	13.86	1.87
Trade				
Import volume				
Low standards food	4.92	-0.36	3.44	-0.13
High standards food	-94.88	13.81	-73.95	4.28
Other commodities	0.56	-0.03	0.33	-0.01

Export volume				
Low standards food	-1.06	-0.01	-0.45	-0.02
High standards food	85.28	0.27	58.15	0.24
Other commodities	-0.83	0.05	-0.54	0.02
Rural labor used in high standards intermediate product				
Poorest rural households	70.00	2.91	22.08	2.90
Other rural households	83.85	3.40	26.31	3.39
Corporate farms	82.40	3.27	26.04	3.29
Domestic consumer price				
Low standards food	1.35	-0.08	0.88	-0.02
High standards food	2.57	1.15	2.09	1.19
Other commodities	0.83	-0.05	0.52	-0.01
Company price				
Low standards food	1.34	-0.08	0.88	-0.02
High standards food	34.89	1.46	11.40	1.47
Other commodities	0.77	-0.04	0.49	-0.01
Farm gate price				
Low standards intermediate product	1.38	-0.08	0.90	-0.03
High standards intermediate product	49.64	2.10	15.99	2.10
Factor price				
Rural labor	1.13	-0.06	0.71	-0.02
Urban labor	0.61	-0.03	0.36	-0.01
Land	3.01	-0.18	1.98	-0.05
Capital	0.85	-0.06	0.58	-0.02
Poorest rural households				
Profit effect from high standards farming	0.19	0.01	0.05	0.01
Profit sharing from corporate farm	0.01	0.00	0.00	0.00
Factor income effect	0.22	-0.01	0.13	-0.00
Among it:				
Labor	0.05	0.00	0.02	0.00
Land	0.17	-0.01	0.12	-0.00
Total income effect	0.42	-0.00	0.19	0.01
Other rural households				
Profit effect from high standards farming	0.20	0.01	0.05	0.01
Profit sharing from corporate farm	0.01	0.00	0.00	0.00
Factor income effect	0.20	-0.01	0.13	-0.01
Among it:				
Labor	0.07	-0.00	0.04	-0.00
Land	0.18	-0.01	0.12	-0.00
Capital	-0.05	-0.00	-0.02	-0.00
Total income effect	0.40	-0.01	0.19	0.00
Urban households				
Profit sharing from corporate farm	0.00	0.00	0.00	0.00
Factor income effect	-0.29	0.01	-0.19	-0.00
Among it:				
Labor	-0.26	0.01	-0.18	0.00
Capital	-0.03	-0.00	-0.01	-0.00
Total income effect	-0.29	0.01	-0.19	-0.00

* Relative price increase=(Price of high standards food/Price of low standards food-1)*100

Note: The comparison is based on common relative price increase, i.e., the two simulations have nearly the same relative price increase.

In Table 3.6, comparison is based on the same relative price increase but on different markets. For the export-led growth, we consider a 25% increase in the relative price of HS on the world market. For the domestic demand growth, we consider a 25% relative price increase in domestic consumer prices. The logic of this comparison is that world price change reveals preference changes of international consumers while domestic consumer price change reveals preference changes of domestic consumers.

The export-led growth has the same effects as in Table 3.5 but smaller in size since the price increase on the world market is lower (25% compared to 46% or 70% in Table 3.5). So rural households benefit less. Their incomes increase by 0.14% for each. However, under the domestic shift in preference, rural households lose significantly with these large domestic price changes. Farm gate prices increase sharply for HS, but decline substantially for LS, causing substantial reduction in income for all rural households and especially for the poor who depend more on LS products for their income.

In summary, these additional comparisons generally confirm our earlier conclusions, but also show that the seemingly same shock, i.e., the same relative price increase, may have quite different welfare impacts depending on the source of the shock, and that different shocks have different transmission mechanisms.

Table 3.6 Comparing Export-led Growth and Domestic Demand Growth
(Percentage change comparing with baseline)

Sim 7A: World price of high standards food increases by 25% ($\Delta pwe_{HF} / pwe_{HF} = +25\%$, $\Delta pwm_{HF} / pwm_{HF} = +25\%$); Import is elastic ($\sigma_{HF}{}^{q} = 3$).
Sim 8A: Urban households' preference for low standards food decreases by 55% ($\Delta\zeta^{U} / \zeta^{U} = -55\%$); Import is elastic ($\sigma_{HF}{}^{q} = 3$).
Sim 7B: World price of high standards food increase by 25% ($\Delta pwe_{PH} / pwe_{PH} = +25\%$, $\Delta pwm_{HF} / pwm_{HF} = +25\%$); Import is inelastic ($\sigma_{HF}{}^{q} = 0.1$).
Sim 8B: Urban households' preference for low standards food decrease by 39% ($\Delta\zeta^{U} / \zeta^{U} = -39\%$); Import is inelastic ($\sigma_{HF}{}^{q} = 0.1$).

	Sim 7A	Sim 8A	Sim 7B	Sim 8B
Aggregate effects				
Real GDP	-0.05	0.71	-0.04	0.06
CPI	0.48	-4.33	0.31	-0.30

Gini coefficient	-0.28	2.21	-0.17	0.03
Real Gini coefficient	-0.25	1.83	-0.15	-0.09
Relative price increase*	25.00	24.87	25.00	25.25
Consumptions				
Low standards food	0.61	-7.71	0.40	-1.24
High standards food	-58.58	97.91	-40.95	78.76
Other commodities	0.05	0.26	-0.01	0.06
Output of final commodities				
Low standards food	0.48	-7.34	0.37	-1.21
High standards food	9.31	51.65	2.41	41.03
Other commodities	-0.12	1.34	-0.08	0.14
Individual output of high standards intermediate product				
Poorest rural households	7.58	45.17	1.89	34.06
Other rural households	8.95	48.92	2.33	39.11
Corporate farms	9.06	43.88	2.46	37.86
Trade				
Import volume				
Low standards food	2.65	-24.81	1.78	-2.95
High standards food	-77.73	1077.32	-44.73	87.89
Other commodities	0.25	-2.04	0.15	-0.13
Export volume				
Low standards food	-0.32	0.17	-0.15	-0.55
High standards food	31.24	-3.02	30.76	-1.70
Other commodities	-0.41	4.06	-0.27	0.36
Rural labor used in high standards intermediate product				
Poorest rural households	14.74	95.51	3.58	71.47
Other rural households	16.21	109.77	4.31	84.60
Corporate farms	15.42	101.03	4.38	81.66
Domestic consumer price				
Low standards food	0.67	-6.37	0.44	-0.56
High standards food	1.64	16.92	1.17	24.55
Other commodities	0.39	-3.52	0.25	-0.29
Company price				
Low standards food	0.67	-6.29	0.44	-0.55
High standards food	7.33	45.14	1.97	35.09
Other commodities	0.37	-3.26	0.24	-0.27
Farm gate price				
Low standards intermediate product	0.69	-6.49	0.45	-0.57
High standards intermediate product	10.23	67.38	2.66	50.64
Factor price				
Rural labor	0.54	-4.79	0.35	-0.37
Urban labor	0.27	-2.18	0.17	-0.14
Land	1.52	-14.31	0.99	-1.25
Capital	0.44	-4.35	0.29	-0.46
Poorest rural households				
Profit effect from high standards farming	0.03	0.33	0.01	0.21
Profit sharing from corporate farm	0.00	0.02	0.00	0.01
Factor income effect	0.10	-0.84	0.06	-0.05
Among it:				
Labor	0.01	0.06	0.00	0.02
Land	0.09	-0.90	0.06	-0.08
Total income effect	0.14	-0.50	0.07	0.17
Other rural households				
Profit effect from high standards farming	0.03	0.32	0.01	0.21
Profit sharing from corporate farm	0.00	0.01	0.00	0.01

Factor income effect	0.10	-1.05	0.07	-0.12
Among it:				
Labor	0.03	-0.18	0.02	-0.01
Land	0.09	-0.93	0.06	-0.08
Capital	-0.02	0.05	-0.01	-0.03
Total income effect	0.14	-0.72	0.08	0.10
Urban households				
Profit sharing from corporate farm	0.00	0.00	0.00	0.00
Factor income effect	-0.15	1.41	-0.10	0.01
Among it:				
Labor	-0.14	1.47	-0.10	0.07
Capital	-0.01	-0.06	-0.00	-0.06
Total income effect	-0.15	1.41	-0.10	0.01

[*] Relative price increase=(Price of high standards food/Price of low standards food-1)*100; For the export-led growth, the increase is on world price. And for the domestic demand growth, the increase is on domestic consumer price.
Note: The comparison is based on common relative price increase, i.e., the two simulations have nearly the same relative price increase.

3.4.6. Sensitivity Analyses

Figures 3.2-3.5 summarize a series of sensitivity analyses (and Figures A3.1 – A3.4 in appendix show the results of further robustness tests). Figures 3.2 and 3.3 show the effect of differences in technology used in HS farming. Figure 3.2 shows under the export-led scenario how rural households will benefit more (less) if the technology used in HS farming is more(less) labor intensive (see also Table A3.2 in Appendix for more details). This effect is strongest for the poorest as is reflected in the different curves for poorer and other rural households. Similarly, Figure 3.3 shows (under the domestic growth scenario) how the rural households (and especially the poorest) will lose less with more labor intensive HS farming (see also Table A3.3 in Appendix for more details).

Figure 3.4 illustrates the impact of credit constraints. Lower (higher) capital supply elasticity represents more (less) credit constraints. The figure shows that income effects for rural households are lower with stronger credit constraints. Capital market imperfections thus limit the potential benefits of HS expansion for farmers.

Figure 3.5 illustrates the effects of investment requirements for HS farmers. The simulations show that in particular poor farmers are negatively affected by higher investment costs.

Figure 3.2 Export-led Expansion under Different Technologies in High Standards Farming
(Baseline = Sim 1A)

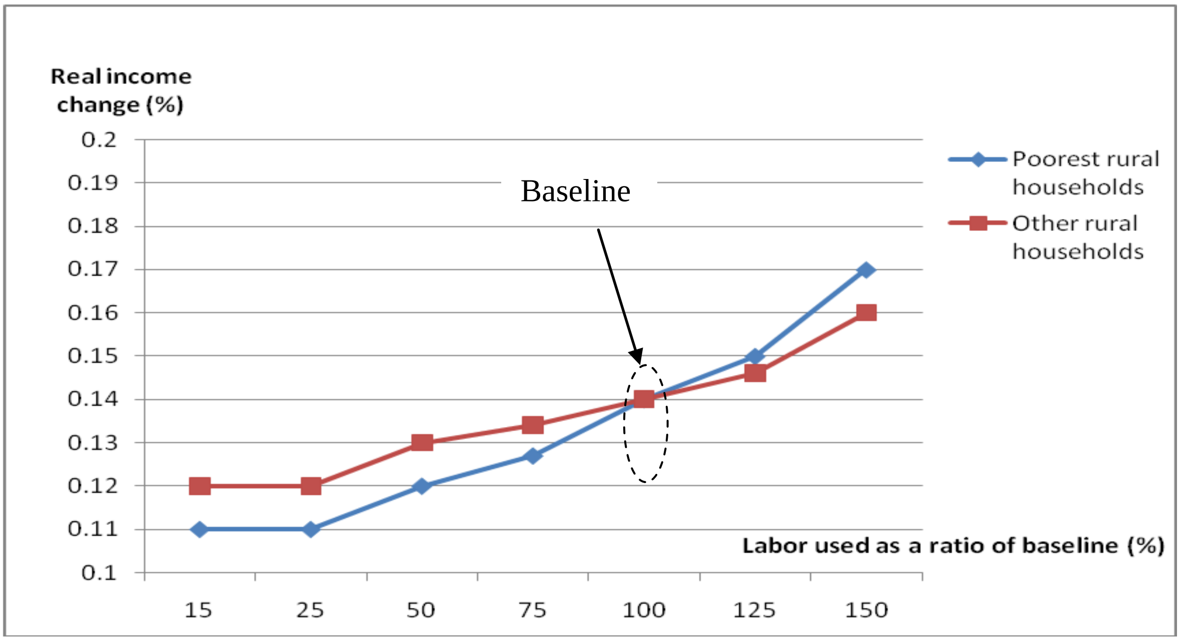


Figure 3.3 Domestic Demand Growth with Elastic Import under Different Technologies
(Baseline = Sim 2A)

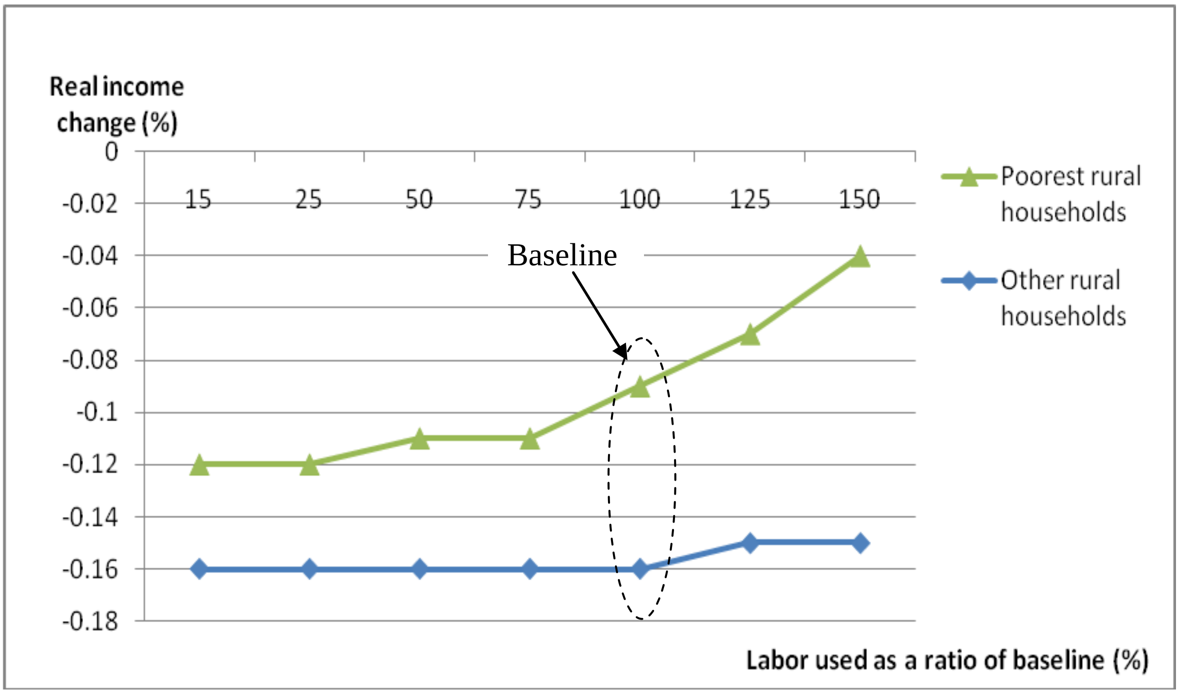


Figure 3.4 Export-led Expansion with Different Credit Constraints
(Baseline = Sim 1A)

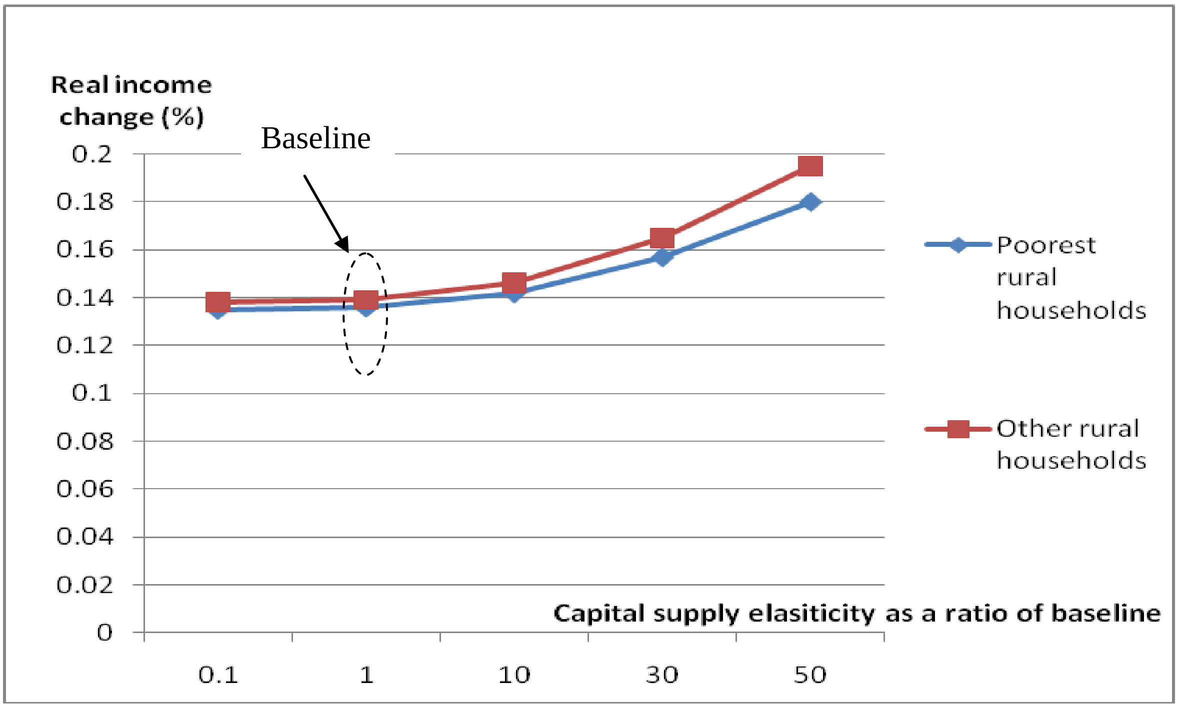
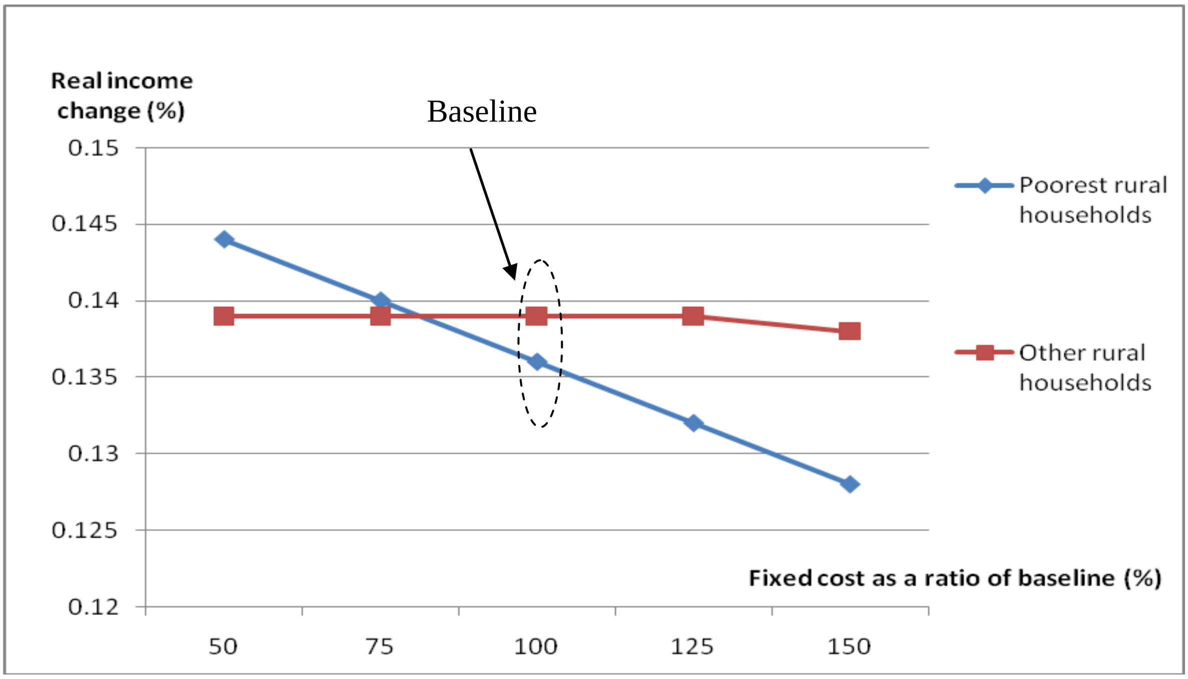


Figure 3.5 Export-led Expansion with Different Fixed Investment Costs
(Baseline = Sim 1A)



3.5. Conclusions and Discussions

In this chapter we analyze how the expansion of high standards food production affect the structural production changes, the incomes of different types of rural and urban households, and the rural poverty and equity by using a CGE model with market imperfections. We explicitly model credit constraints and its consequences for poverty and equity. In addition, we explicitly model households' preferences for high standards food. We use 2005 data from China to calibrate our model and perform two simulations: the effect of an increase in the world price of high standards food and an increase in urban households' preference for high standards food.

This chapter is the first to show the complex set of factors that will determine growth and equity effects of HS growth. First, the simulation results show that poor rural households will expand their production of high standards product with the increase of world price for high standards food. In this way an expansion in the high standards food sector leads to a reduction of poverty and of inequality. Second, expansion of high standards sector resulting from domestic preference changes may increase or decrease real incomes of poor rural households, and hence increases or decreases inequality (depending on whether HS production can compete with HS imports.). Third, the effects are influenced by technology, required investment costs and factor market imperfections. A reduction in credit constraints induces an increase in high standards farming and rural households will gain more. If the technology used in high standards farming is more labor intensive it will benefit the poor more, and vice versa. Fourth, the spillover effects of HS demand growth on other product markets (in this in particular LS markets) is important. Since poor rural households depend importantly on HS production they may benefit or lose from spillover effects. As we showed here, the effects depend, among others, on where HS demand comes from and on substitution between imports and domestic products.

In summary, our chapter shows the importance of taking into account all the relevant effects. The simulation results have shown that the general equilibrium effects can be very different from partial equilibrium effects. The overall welfare effects of standards on poor rural households are determined by the trade-off of all the relevant effects. Overlooking some effects may lead to biased, and sometimes wrong, policy conclusions.

Chapter 4. Extension to the General Equilibrium Model: The Impact of Contracts

4.1. Introduction

Interlinked contracts are one example of so-called ‘hybrid’ organizational forms leading to vertical coordination in rural economies, according to Williamson (1975). Interlinked transactions can be considered as a kind of package deal, with the terms of one transaction contingent upon the terms in another (Bardhan and Udry, 1999). The introduction of higher quality requirements in developing and transition countries has coincided with the growth of contracting (Swinnen, 2007). In global value chains, processing, marketing and input supplying companies have engaged in a variety of forms of contracting with farmers (Reardon et al., 2009; Segura, 2006).

According to the literature, interlinked contracts are beneficial for processors for at least two reasons. First, interlinked contracts allow the trader to counteract the effect of imperfect factor markets on the farmer’s production efficiency (Gangopadhyay and Sengupata, 1987; Vandemoortele et al., 2009). When the farmer faces a high interest rate in the credit market, the trader can encourage the farmer to increase his output by providing credit at a low interest rate and extract the surplus by offering a low purchase price. Second, interlinked transactions can internalize some externalities if moral hazard is an important constraint (Braverman and Stiglitz, 1982).

At the same time, farmers benefit from contracts by gaining access to an assured market. In some cases, net output prices are higher for contracted produce. In such cases crop revenues will be higher as well (Reardon et al., 2009). Farmers also benefit from contracts by obtaining credit to enter into high-value chains. Due to asymmetric information and hence credit rationing, farmers may face difficulties in accessing credit from normal banks (Stiglitz and Weiss, 1981). This kind of market imperfection is especially widespread in developing and transition countries (e.g., Carter, 1988; Swinnen and Gow, 1999) and has substantial impact on the inclusion of smallholders in modern supply chains.

Empirical evidence shows that even though small farmers have incentives to participate in contract farming, they may not be able to get contracts. For example, studies in Latin America and Africa argue that small farmers were being left behind in supermarket-driven horticultural marketing and trade (Dolan and Humphrey, 2000; Key and Runsten, 1999; Reardon et al., 2003; Weatherspoon et al., 2001). One of the reported reasons was that small farmers utilize the granted credit less efficiently due to their smaller scale of operation – which prevents them from exploiting any scale economies (Reardon et al., 2009). On the other hand, smallholders offer some advantages. For example, they may be more able and willing to follow highly labor-intensive field management practices (von Braun et al., 1989) because of weaker bargaining power or because of the availability of cheap family labor. The trade-off between these advantages and disadvantages determines whether they can be included in and benefit from high-value chains.

The development of contract farming in China is particularly relevant for three reasons. First, even though China has sustained high growth rates for nearly thirty years and the continuously increasing income per capita is already leading to structural changes in Chinese diets (Gale and Huang, 2007), the food distribution system has lagged behind in undergoing structural change until very recently. In recent years, however, the arrival of large-scale retail operations (domestic as well as foreign) and some food safety scandals have triggered the start of a transformation process (Hu et al., 2004; Wang et al., 2009). Yet the transition from a system thriving mainly on low standards food produced by millions of small farms[43] (Rozelle and Swinnen, 2004) to one thriving on high standards food is still in its infancy and will undoubtedly have a huge impact on both producers and consumers. Second,

[43] In China, the average farm size is less than 0.5 hectare, which is much smaller than in other Asian developing countries (Fan and Chan-Kang, 2005).

despite high growth rates, rising inequality between poor and wealthy households becomes an increasingly severe problem (Ravallion, 2001). After an initially fast rate of poverty reduction, in the last decade China has been facing considerably more difficulties in reducing rural poverty (Chen and Ravallion, 2007; Riskin, 2004). 90% of poverty is still rural in China (World Bank, 2009). The welfare and poverty effects associated with the expansion of contract farming are therefore potentially very important. Third, both the agricultural commodity and factor markets are in transition. Whereas the commodity market is becoming more and more efficient (Huang and Rozelle, 2006), factor market imperfections remain important. Therefore, China provides a very interesting case for research on the interaction between the food system transition and the acute equity and poverty problems under conditions of market imperfections.

We will first illustrate the rationale for processors to give contracts to farmers by constructing a simple partial equilibrium model. Then we use a CGE model modified from Chapter 3 to simulate the decision of processors and the corresponding welfare effects.

4.2. The Partial Equilibrium Model

Consider an agricultural economy with one representative farmer and one representative processor. The output of the farmer is a function of the amount of labor (*L*) and capital (*K*). The production function is represented by $q = f(L,K)$ with $f_i > 0$, $f_{ii} < 0$, $f_{ij} > 0$, for *i*, *j* = *L* and *K*. We assume constant returns to scale and the farmer's profit is

(23) $\prod_F = pf(L,K) - wL - rK$

where *p* is the price of the farm product, *w* is the price of labor, and *r* is the price of capital.

The output of the processor is a function of farm output. The production function is represented by $Q = g(q)$ with $g_q > 0$, $g_{qq} < 0$, and the profit is

(24) $\prod_P = Pg(q) - pq$

where P is the price of the final product.

4.2.1. Perfect Credit Markets

To establish a point of comparison, we first identify the equilibrium without credit market constraints. With perfect credit markets, farmers are not constrained in the quantity of inputs they use. The farmer will choose the quantity of capital that maximizes his profit given by equation (23). This implies the following equilibrium condition respective to capital demand:

(25) $pf_K - r = 0$

Similarly, for the processor, the maximization of profit given by equation (24) gives the intermediate demand function:

(26) $Pg_q - p = 0$

Because the supply of farm output is flexible to adjust to the processor's demand due to constant returns to scale and perfect markets, the transaction can be carried out through spot markets without any constraints.

4.2.2. Imperfect Credit Markets

To model imperfect credit markets, we follow the general approach of Ciaian and Swinnen (2009) by introducing a farmer credit constraint. It is assumed that the maximum amount of credit (S) that a farmer can borrow depends on farmer characteristics (W) such as the scale of operation, farmer profits, and assets. Hence, $S = S(W)$ with $dS / dW > 0$. The credit constraint is given by

(27) $rK \leq S(W)$

With a credit constraint, the decision-making problem of the farmer is the maximization of his profit function, as given by equation (23), subject to credit constraint (27), as represented by the LaGrange function

(28) $\Psi = pf(L,K) - wL - rK - \lambda(rK - S)$

where λ is the shadow price of the credit constraint.

When the credit constraint is binding, the farmer cannot use the unconstrained optimal level of capital and capital use is determined by $K = S(W)/r$.

With binding credit constraints ($\lambda > 0$), the demand for capital will be given by

(29) $pf_K - r(1+\lambda) = 0$

from which it follows that the marginal value product of capital is higher than the marginal cost of capital *r*: $pf_K > r$. By increasing the level of capital use, the farmer could increase his profit but he cannot use more capital because of the credit constraint. As $f_K > r/p$ (where r/p is the marginal capital productivity with perfect credit market), $f_K > 0$ and $f_{KK} < 0$, output *q* will be lower with imperfect credit markets compared to the case of perfect credit markets.

As farm output is reduced, the processor will be constrained in its procurement. The processor's profit maximization problem then becomes

(30) $\prod_P = Pg(q) - pq$

s.t. $q \leq q_{\max}$

where $q_{\max}$ is the maximum output of the farmer under credit constraints.

Maximization of the corresponding LaGrange function leads to the following intermediate demand function for the processor:

(31) $Pg_q - p - \gamma = 0$

where γ is the shadow price of constraint $q \le q_{\max}$. By using more intermediate inputs, the processor could increase its profit, but it cannot use more intermediate inputs because of the farm output constraint, which results from the credit constraint on the farmer.

This result is an example of a negative vertical externality, which has been explored earlier in a model of double marginalization by Spengler (1950), and leads to a positive incentive for the processor to provide credit contracts to the farmer.[44]

4.2.3. Interlinked Contracts

To overcome the negative vertical externality created by imperfect credit markets, the processor can offer an interlinked contract to its suppliers so as to increase farm output, as well as to acquire exclusive procurement rights on this output. In other words, contingent on selling the output to the processor, farmers are given credit to attenuate their capital constraints.

With the credit given by the processor, farmers can get higher profits. Since the increased profits originate from relaxed credit constraints by the processor, the latter usually has the power to claim a share of them. Different bargaining power between these two players may result in different sharing rules for distribution of the profits (Nash, 1950). The bargaining power is reflected implicitly in the price of the intermediate product paid by the processor. If the processor can discriminate prices between farmers, prices can be derived based on equation (31) as follows:

(32) $$Pg_q - p_q q - p - \gamma = 0$$

where p is now not exogenously given but dependent on the output of farmers. $p_q > 0$ implies that larger farmers will have higher bargaining power.

[44] There is a vast literature documenting these incentives but with probably different explanations, e.g., see Vandemoortele et al. (2009).

Bargaining power can also be calculated explicitly by the share of profit transferred from the farmer to the processor, resulting in the following equation: [45]

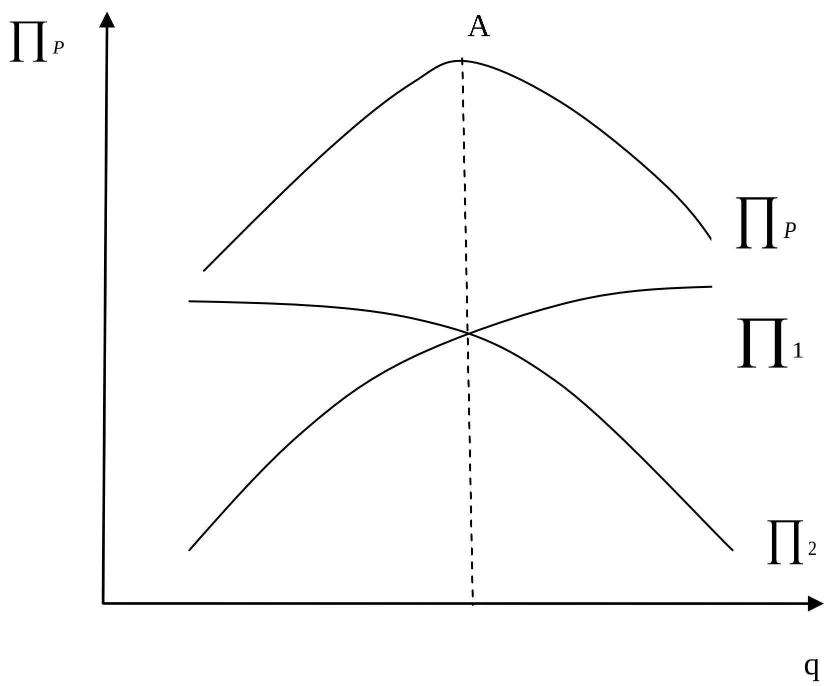
(33) $Pg_q - p - \gamma + \alpha_q \prod_F = 0$

where $\alpha \geq 0$ is the share of profit transferred to the processor and $\alpha_q < 0$.

In both cases, the processor faces a trade-off between increasing its profit by increasing output or by increasing its profit transfer from farmers. In Figure 4.1, line $\prod_1$ shows that the processor's production profits increase with output and line $\prod_2$ shows that the scope for profit transfer from farmers is reduced with increasing output. The sum of these two revenues is represented by $\prod_P$, and $\prod_P$ is maximized at point A.

Since the choice among different farmers is a corner solution when the distribution of farmer types is not continuous, we simulate the decision-making by comparing the profits

Figure 4.1 Trade-off of Processor



[45] This equation uses the FOC of farmer's profit maximization that $\prod_{F_q} = 0$.

among different possible choices of farmer types. Consequently, we study the welfare impact of these choices on farmers by extending the CGE model.

4.3. Modifications of the CGE Model

The current CGE model is based on the model in Chapter 3 with some modifications to account for interlinked contracts. Figure A4.1 and Table A4.1 summarize the model structure, with a symbol (†) to show differences from the model in Chapter 3. In what follows, the main modifications are described.

First, a processor in the high standards sector will have positive profits. Hence its income will increase with output. We assume monopolistic competition in the high standards processing sector by following Harris (1984). Since processors have positive profits, our model can be regarded as a short-run equilibrium (Harris, 1984).[46] This is acceptable for our objective. The optimal pricing rule is the Lerner formula

(34) $(PXI_{poH} - AC_{poH}) / PXI_{poH} = 1/\varepsilon_{poH}$

where PXI_{poH} is the producer price of the high standards final good, ε_{poH} is the perceived demand elasticity, and AC_{poH} is the average cost. The processor's profit can be calculated as:

(35) $\prod_P = (PXI_{poH} - AC_{poH}) * QX_{poH}$

where QX_{poH} is the output level of high standards food.

As in a general equilibrium, all incomes should eventually return to the factor owners, we assume that the profit of the processor is proportionally transferred to the owners of factors used by the processor. This assumption may have a critical impact on the results since processors may as well transfer profits abroad if foreign firms dominate the high standards

[46] As Harris (1984) stated, 'The short run is a period in which industry structure is fixed. The following variables are held constant in the noncompetitive industries: markups on unit cost by firms; number of firms in each industry; number of product lines of each firm; and number of domestic and foreign product lines. … All other economic variables adjust within the short run. This includes commodity and factor prices, outputs, employment of variable factors, etc. This short run is similar to but not quite the same as the Marshallian short run of textbook economics.'

sector (Konan and van Assche, 2007). However, we do not have data on the share of foreign firms in the high standards processing sector and on how they would allocate and distribute their profits. Hence we are not able to capture this effect exactly. A general conjecture is that the benefits to domestic households may be less if foreign firms transfer profits abroad.

Second, interlinked contracts are introduced by relaxing credit constraints for the poorest rural households, other rural households and corporate farms consecutively. We simulate and compare the different cases to find the optimal choice of farmer type for the high standards processor.

Third, we study the impact of rent sharing on farmer welfare by assuming that the farmer profits due to credit from the processor are partially transferred to the latter. The sharing rule for these profit transfers is different and determined by the farmer's bargaining power. We assume a structural distribution of bargaining power among farmers, i.e., farmers with higher efficiency of utilizing capital have higher bargaining power.

4.4. Simulations

We calibrate the model to the Social Accounting Matrix (SAM) in Chapter 3 with some modifications (marked by shading in Table 4.1). First, the high standards processor has positive profits. Because there are no reliable data available on profit rates of high standards processing and because the high standards sector is normally regarded as having a higher profit rate (Reardon et al., 2009), we assume a profit rate of 10%, exceeding the average profit rate of the processing sector (6.2% according to CECFIY (2006)). Second, this profit is transferred proportionally to the owners of factors in this sector through an additional sub-matrix. For calibration, elasticities are drawn from the relevant literature and Table 3.3 in Chapter 3 summarizes elasticities applied in our model. The perceived demand elasticity for high standards products is calibrated to suit the assumed profit rate.

Table 4.1 Archetype SAM of China: With Contracts
(Unit: 100 million Yuan)

	Low	Highs	Highb	highc	Low proc.	High proc.	Other com.	Rural labor	Urban labor	Land	Capital	LaborRCFP	LandCFP	CapitalCFP	cfpro	LaborrPPR	LaboruPPR	LandPPR	CapitalPPR	PPR	High inter.	Poorest rural	Other rural	Urban	S-I	Row
Low					23104.2																					
Highs																					14					
Highb																					207.7					
Highc																					11.7					
Low proc.																						1933.7	14358.2	12513.1	2227.7	1416.8
High proc.																						3	40.6	242.5	119.3	176
Other com.																						2162.4	25836.3	36797.3	77173	42412.6
Rural labor	10514.1	5.7	83.9	4.7	1359.2	9.2	29105.5																			
Urban labor					2365.1	27.6	82926.2																			
Land	4362.9	2.3	34.8	2	1523.3	10.4																				
Capital	8227.2	4.4	65.7	3.7	2876.9	19.6	40037.2																			
LaborRCFP															0.6											
LandCFP															0.2											
CapitalCFP															0.5											
cfpro				1.3																						
LaborrPPR																				4.5						
LaboruPPR																				13.3						
LandPPR																				5.0						
CapitalPPR																				9.5						
PPR						32.3																				
High inter.						233.4																				
Poorest rural		1.6						3727		369.7		0.05	0.02			0.4		0.3								
Other rural			23.3					37355.3		5566	18468.8	0.5	0.2	0.2		4.1		4.7	3.4							
Urban									85318.9		32765.9			0.3			13.3		6.1							
S-I																							21191.4	68551.6		
Row					1220.8	248.9	32312.7																		10223	
Total	23104.2	14	207.7	11.7	32449.5	581.359	184381.6	41082.3	85318.87	5935.7	51234.7	0.55	0.22	0.5	1.3	4.465288	13.33068	5.019374	9.484662	32.3	233.4	4099.1	61426.5	118104.5	89743	44005.4

Note: New added sub-matrices are shown by shading.

Our main objective is to find the impact of credit provision by processors in the high standards sector to different farmer types. This is implemented by adding the same value (50) to the collaterals of different farmers, κ^c.[47] The theoretic model shows that the processor will have higher profits by providing credit due to the removal of the negative vertical externality even without transfer of profits from farmers. Hence, we simulate the effects first without profit transfers, then with profit transfers. Table 4.2 and 4.3 report the simulation results.

4.4.1. Credit Provision Without Profit Transfers

The simulation results of granting 50 units of credit as the collateral of the poorest rural households ($\Delta\kappa^{PR} = 50$) are reported in the first column of Table 4.2. The real incomes of the poorest rural households and the urban households increase by 0.97% and 0.05% respectively. The rise in the income of the poorest rural households results from increasing profits in high standards farming (0.99%). Lower credit constraints lead to a relatively higher production of high standards intermediate products by the poorest rural households (1892.85%). Due to output growth, the high standards processor increases profits by 106.80%.

The simulation results of granting 50 units of credit as the collateral of the other rural households ($\Delta\kappa^{OR} = 50$) are reported in the second column of Table 4.2. The real incomes of the other rural households and the urban households increase (by 0.05% and 0.06% respectively) while the poorest rural households lose by 0.02%. The loss in income of the poorest rural households results from decreasing profits in high standards farming (-0.01%) and decreasing factor incomes (-0.03%). Even though the

[47] The credit from processors works just like a guarantee, helping farmers be able to get more capital from banks. This method makes the comparison among different scenarios possible because the counterfactual changes mean the same cost for the processor.

Table 4.2 Simulation Results: Without Profit Transfers
(Percentage Change)

Sim 9A: Grant 50 units of credit to poorest rural households ($\Delta\kappa^{PR} = 50$)
Sim 9B: Grant 50 units of credit to other rural households ($\Delta\kappa^{OR} = 50$)
Sim 9C: Grant 50 units of credit to corporate farms ($\Delta\kappa^{CF} = 50$)

	Sim 9A	Sim 9B	Sim 9C
Gini coefficient	-0.04	0.02	-0.01
Output of high standards intermediate product	111.22	159.02	273.88
High standards processor profit	106.80	151.81	258.38
Individual output of high standards intermediate product			
Poorest rural households	1892.85	-2.72	-4.21
Other rural households	-2.31	179.03	-4.79
Corporate farms	-2.27	-3.03	5554.47
Domestic commodity price			
Low standards food	-0.05	-0.03	0.08
High standards food	-1.74	-2.36	-3.64
Other commodities	0.02	0.04	0.15
Factor price			
Rural labor	-0.03	-0.00	0.10
Urban labor	0.04	0.06	0.18
Land	-0.20	-0.24	-0.04
Capital*	-0.00	0.02	0.09
Poorest rural households			
Profit effect	0.99	-0.01	-0.02
Transferred profit from HS processor	0.02	0.02	0.04
Transferred profit from CF	-0.00	-0.00	0.11
Factor income effect	-0.03	-0.03	-0.02
Among it:			
Labor	-0.01	-0.01	-0.01
Land	-0.02	-0.02	-0.01
Total income effect	0.97	-0.02	0.11
Other rural households			
Profit effect	-0.01	0.05	-0.02
Transferred profit from HS processor	0.02	0.03	0.05
Transferred profit from CF	-0.00	-0.00	0.10
Factor income effect	-0.03	-0.03	-0.03
Among it:			
Labor	-0.01	-0.01	-0.01
Land	-0.02	-0.02	-0.01
Capital	0.00	0.00	-0.01
Total income effect	-0.02	0.05	0.09
Urban households			
Transferred profit from HS processor	0.02	0.02	0.04
Transferred profit from CF	-0.00	-0.00	0.02
Factor income effect	0.04	0.04	0.04
Among it:			
Labor	0.03	0.04	0.05
Capital	0.00	0.00	-0.01
Total income effect	0.05	0.06	0.09

* Because high standards farming sector is relatively labor intensive comparing with other non-agricultural sectors, the expansion of this sector results in lower price for capital. When we assume a capital intensive technology for high standards farming, the expansion results in higher capital price, which has been checked by the authors.

Table 4.3 Simulation Results: With Profit Transfers
(Percentage Change)

Sim 10A: Grant 50 units of credit to poorest rural households ($\Delta\kappa^{PR} = 50$)
Sim 10B: Grant 50 units of credit to other rural households ($\Delta\kappa^{OR} = 50$)
Sim 10C: Grant 50 units of credit to corporate farms ($\Delta\kappa^{CF} = 50$)

	Sim 10A	Sim 10B	Sim 10C
Gini coefficient	0.06	0.04	0.00
Output of high standards intermediate product	111.28	159.02	273.88
Processor profit	229.39	201.16	286.32
Individual output of high standards intermediate product			
Poorest rural households	1893.33	-2.72	-4.21
Other rural households	-2.29	179.03	-4.79
Corporate farms	-2.24	-3.03	5554.48
Domestic commodity price			
Low standards food	-0.06	-0.04	0.07
High standards food	-1.73	-2.36	-3.65
Other commodities	0.02	0.04	0.15
Factor price			
Rural labor	-0.03	-0.00	0.10
Urban labor	0.04	0.07	0.18
Land	-0.25	-0.25	-0.05
Capital	-0.01	0.02	0.09
Poorest rural households			
Profit effect	0.10	-0.01	-0.02
Transferred profit from HS processor	0.04	0.03	0.05
Transferred profit from CF	-0.00	-0.00	0.10
Factor income effect	-0.03	-0.03	-0.02
Among it:			
Labor	-0.01	-0.01	-0.01
Land	-0.02	-0.02	-0.01
Total income effect	0.10	-0.01	0.10
Other rural households			
Profit effect	-0.01	0.02	-0.02
Transferred profit from HS processor	0.04	0.04	0.05
Transferred profit from CF	-0.00	-0.00	0.09
Factor income effect	-0.03	-0.03	-0.03
Among it:			
Labor	-0.01	-0.01	-0.01
Land	-0.02	-0.02	-0.01
Capital	0.00	0.00	-0.01
Total income effect	-0.00	0.03	0.09
Urban households			
Transferred profit from HS processor	0.03	0.03	0.04
Transferred profit from CF	-0.00	-0.00	0.01
Factor income effect	0.04	0.04	0.04
Among it:			
Labor	0.04	0.04	0.05
Capital	0.00	0.00	-0.01
Total income effect	0.08	0.07	0.10

weaker credit constraints lead to an expansion of the high standards farming sector, this expansion leads to the expansion of the high standards processing sector directly and of other commodities indirectly through lower factor prices and higher real incomes. Both the high standards processing sector and the other commodity sector utilize relatively more factors mainly located in urban area, like urban labor and capital. As a result, the prices of these factors increase while prices of other factors decrease. An asymmetric reduction of credit constraints leads to a higher share of production of high standards intermediate products by the other rural households (179.03%) and a lower share of production by the poorest rural households (-2.72%). Due to the increase in high standards farm output, the high standards processors increase profits by 151.81%.

The simulation results of granting 50 units of credit as the collateral of corporate farms ($\Delta\kappa^{CF} = 50$) are reported in the last column of Table 4.2. The real incomes of all households increase (by 0.11%, 0.09% and 0.09% respectively). The gain in the income of the poorest rural households results from increasing transferred profits both from corporate farms (0.11%) and from the high standards processor (0.04%). Even though the lower credit constraints for the corporate farms lead to decreasing profit (-0.02%) and decreasing factor incomes (-0.02%), the transferred profits compensate for these losses and generate a positive effect. An asymmetric reduction of credit constraints leads to a higher share of production of high standards intermediate products by the corporate farms (5554.47%). Due to the increase in high standards farm output, the high standards processor increases its profits by 258.38%.

Based on the three simulations the high standards processor will maximize its profits by providing credit to the corporate farms. This preference to work with larger farms has been described extensively in the empirical literature (e.g., Carter and Mesbah, 1993; Dolan and Humphrey, 2000). However, even though the poorest rural households lose by being excluded from participating in the contracts, they benefit from profit transfers, especially of the profit from corporate farms, which use more rural factors as inputs.

4.4.2. Credit Provision with Profit Transfers

In contrast with the simulations in the last sub-section, we will now assume that farmers transfer a part of the profits obtained through increased access to credit to the high standards processor. The literature tells us that corporate and large farms usually have higher bargaining power than small farmers (Reardon et al., 2009). Hence we assume that 90% of the profit surplus of poorest rural households will be transferred to the processor, while only 50% and 10% will be transferred by other rural households and corporate farms respectively.[48] Results are reported in Table 4.3.

In the third row of Table 4.3 we see that even after accounting for profit transfer, the high standards processor still gains more profits by providing credit to corporate farms. Interestingly, when we compare the results for contracting with the poorest rural households and other rural households, we find that the processor can benefit more from granting credit to the poorest rural households (229.39%) than to other rural households (201.16%). This means that when having to choose between these two farmer types, the processor will choose to sign contracts with the poorest rural households, whose weaker bargaining power makes them attractive for contracting.[49] Several studies provide evidence of the inclusion of small farmers in

[48] The distribution of profits between farms and processors are endogenous in reality (Swinnen and Vandeplas, 2007). The endogeneity comes from competition both between farmers and processors, and among rural households and corporate farms. However, to allow comparison of different scenarios, we use a structurally reasonable assumption. As will be presented in the following subsection, the sensitivity analyses show that this assumption has a minor impact on the results since the most critical factor in the current situation is efficiency of farms.

[49] This results are driven by the assumption of division rule between farmers and processors and will be subject to sensitivity analyses.

high standards value chains, but with different explanations (see e.g., Dries and Swinnen (2004); von Braun et al. (1989)).

Moreover, even though poorest rural households transfer most of their profit surplus to the processor, they do keep 10% of the profit surplus for themselves and benefit from the profit transfer from the processor (0.04%). After compensating for the reduction of factor incomes (-0.03%), these effects lead to an overall positive welfare effect (0.10%).

4.4.3. Sensitivity Analyses

In order to assess the robustness of our results we perform sensitivity analysis of the key assumptions.[50] Because different combinations of efficiency and bargaining power can result in different patterns of decision making by processors, we especially verify the robustness of these effects by weakening poorest rural households' credit constraints through a change in the capital supply elasticity. Figure 4.2 shows the impact of different capital supply elasticity of poorest rural households. The horizontal axis measures the capital supply elasticity of poorest rural households ε^{PR}. The left and right vertical axes measure profit change of processor and income change of poorest rural households respectively. In the baseline, when the capital supply elasticity is 0.7, the processor's profit increases by 229.39% and the real income of poorest rural households increases by 0.1%. And when the capital supply elasticity is larger (1.3), the processor's profit increases more (333.02%) and the real income of poorest rural households increases more (0.15%). As expected, the increase in the capital supply elasticity leads to the processor's profit increase because of increasing high standards intermediate products, and hence increases their chances to

[50] A full set of sensitivity analysis results is available from the authors upon request.

enter into contracts. At the same time, the welfare of the poorest rural households increases.

Figure 4.3 shows the impact of different profit transfer rate of poorest rural households. When the profit transfer rate is equal to 0.9, 90% of profit surplus due to credit grant is transferred to the processor. Higher profit transfer rate means weaker bargaining power. In the baseline simulation, when 90% of the profit surplus is transferred to the processor, the processor's profit increases a lot (229.39%) and the real income of poorest rural households increases a little (0.1%). And when 50% of the profit surplus is transferred to the processor, the processor's profit increases less (174.86%) and the real income of poorest rural households increases more (0.49%). These results mean that the decrease of profit transfer to the processor increases their real income (as compared to when they keep a smaller share of the profits for

Figure 4.2 Contracts with Profit Transfers: Impact of Higher Capital Supply Elasticity of Poorest Rural Households
(Percentage Change; Baseline=Sim 9A)

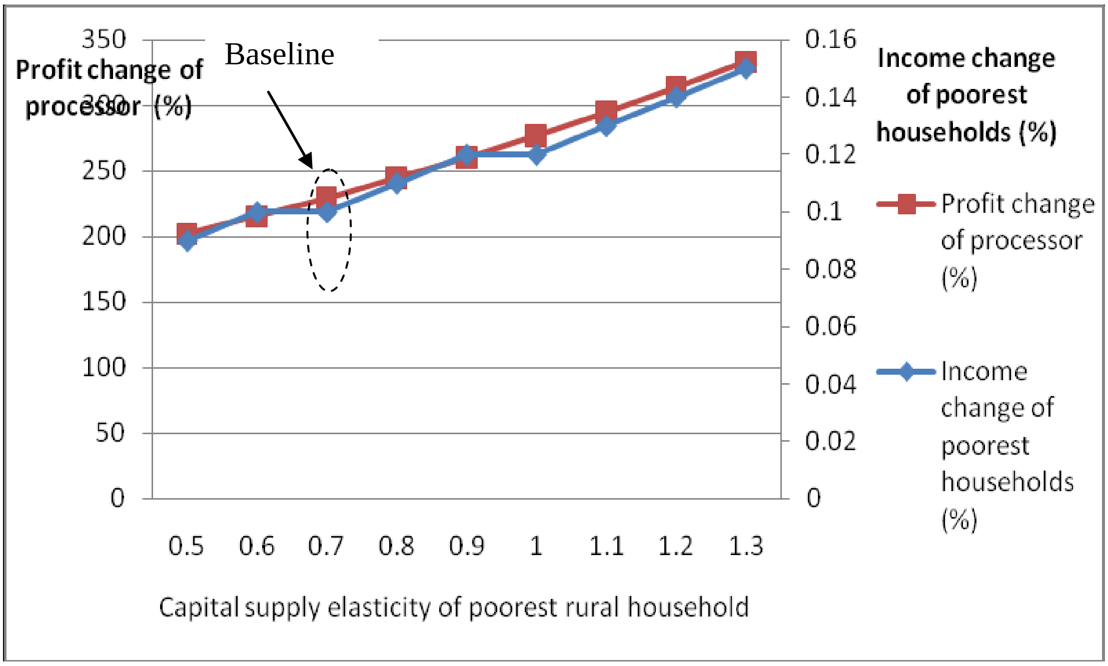
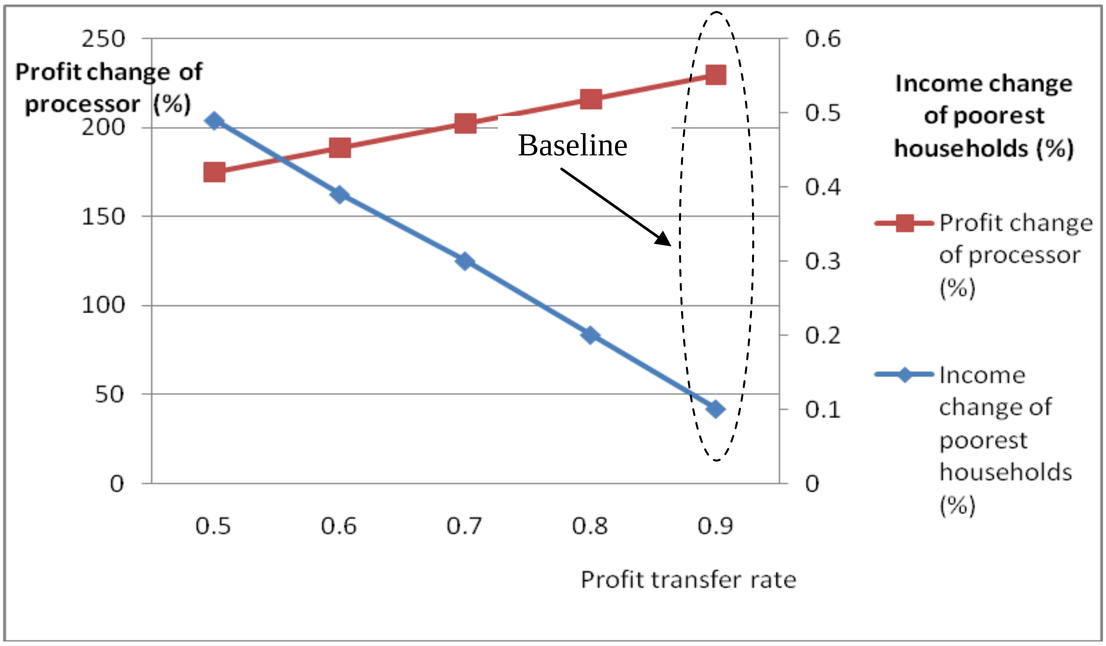


Figure 4.3 Contracts with Profit Transfers: Impact of Profit Transfer Rate of Poorest Rural Households
(Percentage Change; Baseline=Sim 10A)



themselves, all else equal), but obviously also decreases the contracting opportunities for small farmers because the processor gains less from contracts. The figure clearly shows the trade-off between getting contracts and gaining more from contracts.

4.5. Conclusions

In this paper we analyze how a processor determines which farmer type to contract with and how this choice affects the incomes of different types of rural and urban households. Through a CGE model, which is a modified version of the model in Chapter 3, we simulate the decision making of the high standards processor and its impact on the incomes of households under conditions with and without profit transfers. First, we find that the high standards processor prefers entering into contracts with corporate farms because those can most efficiently transform the provided capital into output when there is no bargaining on the profit surpluses of farmers. Second, even when the processor can appropriate a share of the surplus from its suppliers and corporate farms have stronger bargaining power than other farms, corporate farms are preferred because of the dominating efficiency effect in our simulation conditions. However, when surpluses are shared, the weaker bargaining power of poorest rural households may make them more attractive contract partners than other rural households. If poor rural households enter into these contracts, they can benefit, even though they will benefit less than in the case without surplus sharing. The latter case is however less likely to occur due to competition for contracts between farmers, i.e., the processor will choose corporate farms to contract with and poor rural households have no chances of getting contracts because corporate farms are more efficient to utilize the extra credit and hence help the processor to increase its profits. In the case of China, where there are few corporate farms, poor rural households can get more chances of contracting.

Contracts in the high standards sector can serve as an instrument for poverty reduction. We find that inclusion in high standards farming is an effective instrument for poverty reduction. The efficiency consideration of processors may exclude small farmers. However, if processors take into account the weaker bargaining power of small farmers, the latter may have more chances to be included.

In several simulations, results are highly affected by the assumption of distribution of profits among domestic factor owners. If this assumption is not robust, results will be different. For example, when the high standards sector is dominated by foreign firms, profits may be transferred abroad. As a result, rural households may benefit less since they cannot capture a share of the increased profits from processors.

Chapter 5. An Application of the General Equilibrium Model: Scandal and Reforms in China's Dairy Sector

5.1. Introduction

A series of recent studies have identified the spread of 'high standards' as having a fundamental impact on the process of development (Farina and Reardon, 2000; Swinnen, 2007). The growing demand of wealthy consumers for high quality, safety, health, and ethical standards put pressure on governments to increase public regulatory standards and on private processing and retailing companies to introduce or tighten private corporate standards (Swinnen and Vandemoortele, 2008).

Although high standards emerged initially in rich countries, they now affect poorer countries through several channels. First, standards in richer countries are also imposed on imports and consequently have an impact on producers and traders in exporting nations (Jaffee and Henson, 2004; Unnevehr, 2000). Second, global supply chains are playing an increasingly important role in world food markets and the growth of these vertically coordinated marketing channels is facilitated by increasing standards (Swinnen, 2007). Third, higher standards in developed countries are often regarded as a guarantee of quality and gain preference of consumers with higher income in developing countries. This is especially the case when the demand for high standards products cannot be satisfied by local suppliers.

Take China as an example. Constrained by imperfect factor markets, the food supply chain is unable to satisfy the fast growing demand for high standards food. The incompatibility between the fast growing demand and the laggard supply has been leading to some serious food safety problems, such as the tainted milk scandal which occurred in 2008 (Faireclough and Chao, 2008; The Economist, 2008). After the milk scandal, the import of high standards milk products, such as baby formula, increased a lot.

Generally, food safety crises often evolve as follows (e.g., BSE crisis in EU, (Vos, 2000)). First, following the crisis, consumer confidence plummets and the market collapses. Second, to regain confidence and rebuild the market, governments release regulations quickly. Third, the combined impact from the shock and the regulations often exclude the most vulnerable farmers from the market. Foreseeing this negative impact, governments usually introduce some policies like interim subsidies to attenuate the cost of adjustment.

The Chinese tainted milk scandal proceeded in a similar way but with some special characteristics due to the peculiar structure of the Chinese dairy market. More specifically, there is fierce competition, on the one hand among millions of small dairy farmers, on the other hand among hundreds of dairy processing companies (Huang et al., 2007). In between, there are numerable intermediary traders (or middlemen) and milk stations. Although such a system is found to be inclusive for poor farmers as no midstream firm exerts market power (Huang et al., 2008), it does lead to weak traceability, limited capacity for food safety management and low compliance with food safety standards. Policy makers face a critical dilemma between upgrading the dairy production system to higher quality and safety standards (for which increasing scale would probably be a condition sine qua non), and ensuring continued involvement of small-scale farmers who derive their primary incomes from milk production. The outbreak of the scandal and the subsequent dairy reforms provide a unique opportunity to investigate the possible impacts of differently oriented policies.

Note that since the dairy sector is relatively small, constituting only 0.1% of the whole economy, its impact on the overall economy is very small, which means that the general equilibrium effects may not be significant. Hence, the simulations in this chapter should mainly be regarded as an exercise to show how to implement our model for the analysis of some special events. However, using CGE to analyze changes in small sectors is not a new idea (see e.g., Konan and van Assche (2007) on telecom in Tunisia and Waschik and Fraser (2007) on wool industry in Australia).

5.2. Overview of the Process of the Scandal and the Following Reforms

The 2008 Chinese milk scandal was a food safety incident in China involving milk and infant formula, and other food materials and components, adulterated with melamine. The root of the scandal lies in the fast growing demand for milk in combination with a backward supply system. Since 1998, fluid milk consumption in urban China has grown annually at double digit rates (Fuller et al., 2006). However, the growth of demand created various inefficiencies as adaptation to marketing rules, infrastructure, and institutions have not kept pace with the changing environment. The regulation system also lagged far behind the demand (Enderwick, 2009).

The scandal raised concerns about food safety in mainland China, and damaged the reputation of China's food exports with at least 25 countries stopping all imports of mainland Chinese dairy products (Enderwick, 2009). Consumer panic resulting from the contaminated milk lowered overall demand for dairy products substantially.

Shortly after the scandal erupted, sales fell by 30-40% on a comparative basis, according to the Chinese Dairy Association. The Association estimated that the financial effect is of the order of ¥20 billion, and forecasted that confidence might take up to two years to be fully restored. As a result of the huge decline in demand, many small farmers found themselves forced to pour away milk and sell off their cows.

Admitting the lax ‘supervision and management’ by the Chinese Premier Wen Jiabao, the Chinese government responded quickly to the food crisis by staging ‘The State Dairy Food Safety Supervision and Regulation Act’ (CSC, 2008) in an attempt to heavily regulate the dairy market and to restore consumer confidence, both domestically and internationally.

The featured act established specific barriers to market entry, e.g. requiring local governments to set a minimum scale for cow hotels,[51] as well as the introduction of Hazard Analysis Critical Control Points (HACCP). Meanwhile, reference prices for milk were fixed at the county-level in order to stabilize the market (State-Council, 2008, Oct. 9 Article No. 23). On November 2008, a report named 'Consolidation and Revitalization of the Dairy Industry' (CNDRC, 2008) was jointly released by the National Development and Reform Commission and the Ministry of Industry, emphasizing the urge to increase the scale of dairy farming. For example, one of the outlined objectives was to 'increase the share of large scale dairy hotels with more than 100 cows from less than 20% to around 30%' by the end of October 2011. At the same time, this document described some policies to attenuate the negative effects of the market shock and the stringent regulations by giving interim relief subsidies to dairy farmers. In July 2009, a new dairy policy[52] was released jointly by the National Development and Reform Commission and the Ministry of Industry, imposing a substantial increase in the minimum investment threshold to enter dairy farming. These acts will no doubt raise operating and entry costs in the dairy industry and lead to more consolidation of the sector. As public standards are being tightened in the dairy sector in China, they will bring about upheaval in the production system, market structure, rural institutions, and millions of farmers' welfare.

5.3. Simulations

We calibrate the model to the Social Accounting Matrix (SAM) in Chapter 3 with a major modification: the data of the high standards farming sector are replaced by specific

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[51] This is the translation of the Chinese word 'Yangzhixiaoqu', referring to places where farmers jointly raise their cows.

[52] 'Dairy Industry Policy (2009 Revised)' (CNDRC, 2009)

data for high standards dairy farming (See Table 5.1 for details). The input/output, consumption and trade of this high standards sector are changed accordingly.

Our main objective is to find the impact of the scandal and the following dairy reforms. This is realized by changing the preferences of consumers, increasing fixed costs of high standards dairy farming and giving subsidies to other rural households to relax their credit constraints.

5.3.1. Increasing Preference for High Standards Dairy Products

The direct impact of the scandal is the change in consumer preferences for high standards dairy products. Hence, first we simulate the scandal's impact on demand by increasing the preference for high standards food. We explore this case under two situations: one with normal dairy imports and another with more elastic imports. Results are reported in the first two columns of Table 5.2.

When consumer preferences for high standards dairy products increase ($\Delta\zeta^c / \zeta^c = -25\%$) and the Armington elasticity of substitution for the high standards dairy sector is normal ($\sigma_{HF}{}^q = 3$), the real incomes of the poorest rural households and other rural households increase (by 0.20% and 0.07% respectively). The rise in the incomes results from increasing profits in high standards dairy farming (0.23% and 0.12% respectively). Increased preferences for high standards dairy products lead to a higher price of these products (+31.17%) and hence to a relatively higher production of high standards milk by the poorest as well as other rural households (31.09% and 30.58% respectively).

However, the above case can happen only when these preferences change gradually with increasing income. If preferences change abruptly, for example as a result of a food crisis, imports may increase a lot, reflected in a higher Armington elasticity for the high

Table 5.1 Archetype SAM of China when the Same Technology Is Used in High Standards and Low Standards Dairy Farming
(Unit: 100 million Yuan)

	Low	Highs	Highb	highc	Low proc.	High proc.	Other com.	Rural labor	Urban labor	Land	Capital	LaborRCFP	LandCFP	CapitalCFP	cfpro	LaborrPPR	LaboruPPR	LandPPR	CapitalPPR	PPR	High inter.	Poorest rural	Other rural	Urban	S-I	Row
Low					23215.1																					
Highs																					12.0					
Highb																					95.7					
Highc																					12.0					
Low proc.																						1910.7	14366.6	12595.7	2274.1	1372.9
High proc.																						1.2	13.3	160.3	72.9	13.4
Other com.																						2162.4	25836.3	36797.3	77173.0	42412.6
Rural labor	10564.6	4.4	35.0	4.4	1318.6	9.2	29105.5																			
Urban labor					2365.1	27.6	82926.2																			
Land	4383.8	1.8	14.5	1.8	1523.3	10.4																				
Capital	8266.7	3.4	27.4	3.4	2876.9	19.6	40037.2																			
LaborRCFP															0.7											
LandCFP															0.6											
CapitalCFP															1.1											
cfpro				2.3																						
LaborrPPR																				4.5						
LaboruPPR																				13.3						
LandPPR																				5.0						
CapitalPPR																				9.5						
PPR						32.3																				
High inter.						119.6																				
Poorest rural		2.3						3701.4		369.7		0.06	0.04			0.4		0.3								
Other rural			18.7					37340.4		5566.0	18468.8	0.6	0.5	0.4		4.1		4.7	3.4							
Urban									85318.9		32765.9			0.7			13.3		6.1							
S-I																							21191.4	68551.6		
Row					1220.8	42.4	32312.7																		10223	
Total	23215.1	12.0	95.7	12.0	32519.9	261.0	184381.6	41041.8	85318.9	5935.7	51234.7	0.7	0.6	1.1	2.3	4.5	13.3	5.0	9.5	32.3	119.6	4074.3	61407.6	118104.8	89743.0	43798.9

Table 5.2 Simulation Results: The Same Technology in High Standards and Low Standards Dairy Farming
(Percentage Change)

Sim 11A: Households' preferences for low standards food decrease by 25% ($\Delta\zeta^c/\zeta^c = -25\%$); Import is normal ($\sigma_{HF}{}^q = 3$).
Sim 11B: Households' preferences for low standards food decrease by 25% ($\Delta\zeta^c/\zeta^c = -25\%$); Import is normal ($\sigma_{HF}{}^q = 9$).
Sim 12A: Fixed costs increase by 10 times ($\Delta\psi^c/\psi^c = 10$).
Sim 12B: Fixed costs increase by 10 times ($\Delta\psi^c/\psi^c = 10$) and preference for high standards food increase by 25% ($\Delta\zeta^c/\zeta^c = -25\%$).
Sim 13: Collateral of other rural households increase by 10 ($\Delta\kappa^{OR} = 10$).

	Sim 11A	Sim 11B	Sim 12A	Sim 12B	Sim 13
Gini coefficient	0.03	1.10	0.03	0.06	0.04
Individual output of high standards intermediate product					
Poorest rural households	31.09	32.77	0.01	31.10	-0.92
Other rural households	30.58	31.48	0.02	30.61	93.63
Corporate farms	35.71	36.14	0.03	35.74	-1.08
Domestic commodity price					
Low standards food	-0.35	-3.17	-0.00	-0.35	-0.10
High standards food	31.17	20.72	-0.01	31.15	-0.92
Other commodities	-0.16	-1.76	-0.00	-0.16	-0.02
Factor price					
Rural labor	-0.24	-2.42	-0.02	-0.26	-0.08
Urban labor	-0.07	-1.10	-0.01	-0.08	0.02
Land	-0.83	-7.21	-0.03	-0.86	-0.27
Capital	-0.26	-2.16	0.03	-0.23	-0.05
Poorest rural households					
Profit effect	0.23	0.25	-0.04	0.18	-0.00
Transferred profit from HS processor	0.01	0.01	-0.00	0.01	0.01
Transferred profit from CF	0.02	0.02	-0.01	0.01	-0.00
Factor income effect	-0.05	-0.45	-0.02	-0.07	-0.04
Among it:					
Labor	0.00	-0.01	-0.01	-0.01	-0.02
Land	-0.05	-0.45	-0.00	-0.06	-0.02
Total income effect	0.20	-0.17	-0.07	0.14	-0.03
Other rural households					
Profit effect	0.12	0.13	-0.02	0.10	0.04
Transferred profit from HS processor	0.02	0.02	0.00	0.02	0.01
Transferred profit from CF	0.01	0.01	-0.01	0.01	-0.00
Factor income effect	-0.08	-0.53	-0.00	-0.08	-0.04
Among it:					
Labor	-0.01	-0.10	-0.01	-0.02	-0.02
Land	-0.06	-0.46	-0.00	-0.06	-0.02
Capital	-0.01	0.03	0.01	-0.00	0.00
Total income effect	0.07	-0.37	-0.03	0.04	0.01
Urban households					
Transferred profit from HS processor	0.01	0.01	0.00	0.01	0.01
Transferred profit from CF	0.00	0.00	-0.00	0.00	-0.00
Factor income effect	-0.01	0.66	0.00	-0.01	0.04

Among it:					
Labor	0.03	0.69	-0.01	0.02	0.04
Capital	-0.04	-0.03	0.01	-0.03	-0.00
Total income effect	0.00	0.68	0.00	0.00	0.05

standards dairy food. When preferences change and the Armington elasticity is higher ($\sigma_{HF}{}^{q} = 9$), the real incomes of the poorest rural households and other rural households decrease (by 0.17% and 0.37% respectively). The decrease in incomes results from decreasing factor incomes (-0.45% and -0.53% respectively) even though they still have more profits (increasing by 0.25% and 0.13% respectively). The lower factor incomes come from the lower factor prices due to higher imports, leading to a reduction in demand for domestic factors. Competition with imported dairy products leads to a more moderate price increase of high standards dairy products (+20.72%, compared to 31.17% in the previous case). However, the factor prices decrease a lot and lead to higher profits in high standards dairy farming.

5.3.2. Increasing Fixed Costs for High Standards Dairy Farming

Shortly after the scandal, the government released new series of regulations, most of which required extra investments in the dairy production system. Hence, we explore the impact of stringent regulation by increasing the fixed capital costs of production. Results are reported in the third column of Table 5.2.

When fixed capital costs in high standards dairy farming increase ($\Delta\psi^{c}/\psi^{c} = 10$), the real incomes of the poorest rural households and other rural households decrease (by 0.07% and 0.03% respectively). The reduction in incomes results from decreasing profits in high standards dairy farming (-0.04% and -0.02% respectively). Increasing fixed costs has no direct impact on the prices of high standards dairy products and only results in decreasing profits. In fact, the price of high standards dairy products decreases by 0.01% due to a reduced overall income for the economy.[53]

However, if increased fixed costs lead to higher preferences for high standards dairy products, rural households may benefit. Simulation 8B shows the case where preferences for low standards dairy products decrease by 25% ($\Delta\zeta^c / \zeta^c = -25\%$) simultaneously with the cost increase. The real incomes of the poorest rural households and other rural households increase (by 0.14% and 0.04% respectively).

5.3.3. Subsidies to Large-scale Farmers

To attenuate the negative impacts of the milk scandal, the Chinese government has given interim subsidies to those farmers above a specific threshold scale.[54] Hence, we check the impact of subsidies by asymmetrically relaxing credit constraints of other rural households,[55] as the subsidies are usually given to them because of their larger scale of operation. Results are reported in the last column of Table 5.2.

When the collateral of other rural households increases ($\Delta\kappa^{OR} = 10$), the real incomes of the poorest rural households decrease by 0.03%. In contrast, the incomes of other rural households increase by 0.01%. The decrease in income of the poorest rural households results from a decreasing factor income (-0.04%). While the lower credit constraints lead to an expansion of the high standards farming sector, its expansion leads to the expansion of the high standards processing sector directly and of other commodities indirectly through the lower factor prices and higher real incomes. Both the high standards processing sector and

[53] The real GDP decreases by 0.01%. The reason of decreasing overall income is due to the use of resources as investment costs.

[54] There is no national standard on this scale. Local governments decide it based on the local situations. For example, in Beijing, the minimum scale is twenty cows. Generally, this policy will benefit bigger farmers while doing harm to small farmers.

[55] Since we cannot differentiate the households involved in dairy farming from those which are not, we treat the archetype ‘other rural’ households as households which can benefit from the subsidy policy. This treatment will have no impact on the direction of the simulation results, but will attenuate the specific effects on those bigger dairy farming households.

the other commodity sector use more factors which are mainly located in the urban area such as urban labor and capital. As a result, those factors' prices increase while other factors' prices decrease. The overall factor income effect for the poorest rural households is negative.

5.3.4. Sensitivity Analyses

In order to assess the robustness of our results we perform sensitivity analysis of the key assumptions.[56] Because increased fixed costs means higher quality standards and may lead to different scenarios of changes in preferences for high standards dairy products, we verify the results of these changes in Figure 5.1, showing that if the increase in fixed costs leads to a 15% reduction in preferences for low standards dairy products, the poorest rural households will benefit from this change. This result means that when consumers really prefer high standards food, increasing standards may induce a higher demand and hence benefit rural households even though they have to make extra investments to comply with the new standards.

Figure 5.2 shows that when credit constraints of other rural households are relaxed due to subsidies to larger dairy farmers, the welfare effects on the poorest rural households will be different. If we assume that larger farmers are more labor intensive (e.g., 50% more labor intensive), the poorest rural households experience positive welfare effects, originating from the positive labor market effect as the expansion of high standards dairy farming leads to an increased demand for rural labor. When the dairy production technology used by other rural households is neutral or capital intensive, the poorest rural households will lose.

[56] A full set of results from the sensitivity analyses is available from the authors upon request.

Figure 5.1 Welfare Change when Increased Investment Costs Lead to Preference for High Standards Dairy Products
(Percentage Change; Baseline=Sim 11A)

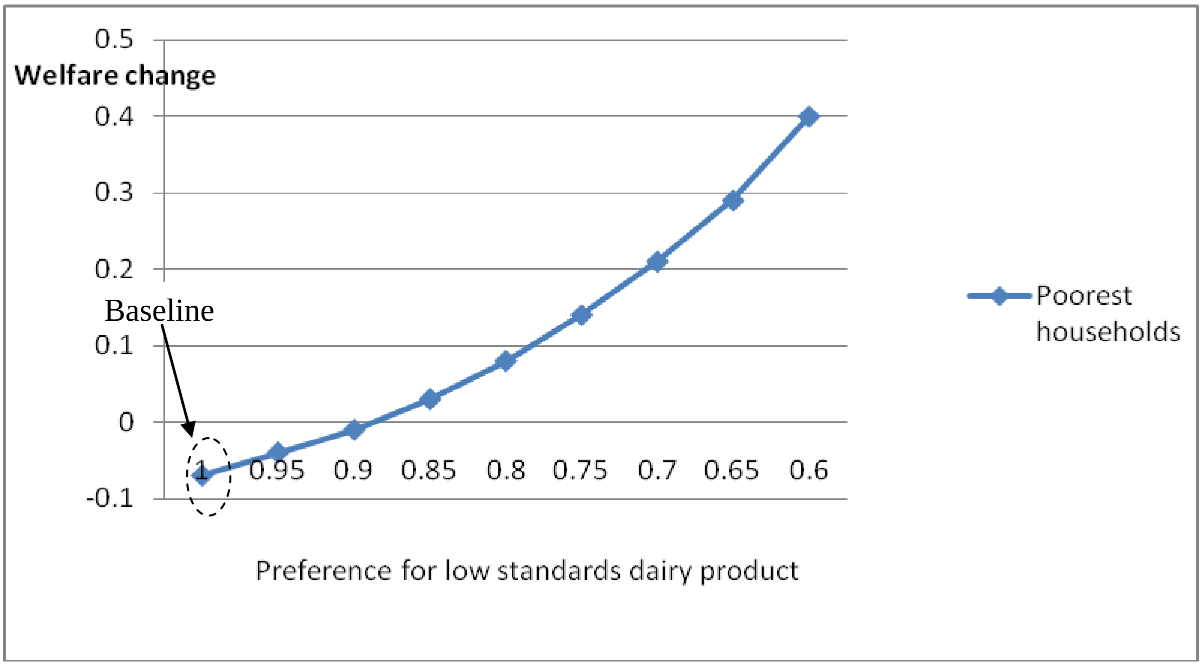
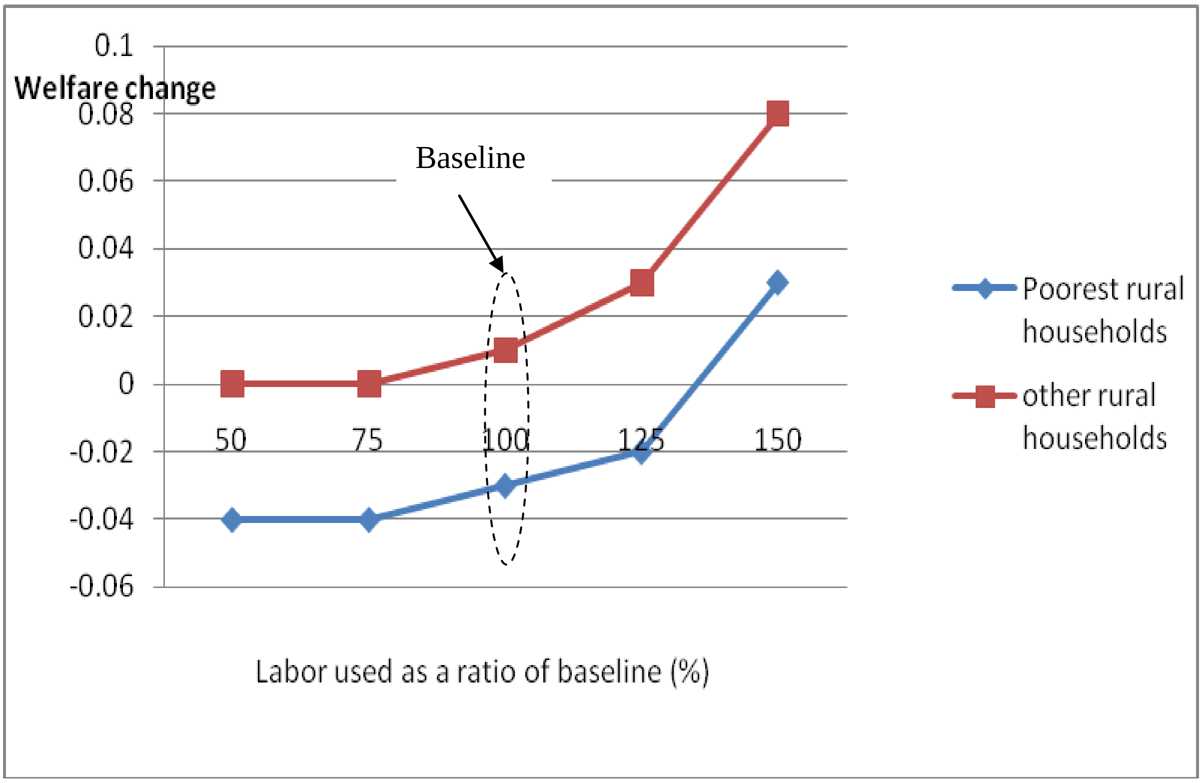


Figure 5.2 Relaxing Credit Constraints for Other Rural Households under Different Technologies
(Percentage Change; Baseline=Sim 13)



5.4. Conclusions

In this chapter we analyze how the 2008 tainted milk scandal and the subsequent dairy reforms affect the incomes of different types of rural and urban households. Through a CGE model, which is a modified version of the model presented in Chapter 3, we simulate the impact of the milk scandal and dairy reforms by increasing consumer preferences for high standards dairy products, increasing the fixed costs of dairy farming and giving subsidies to other rural households.

First, we find that under different assumptions on the Armington elasticity of substitution, rural households will be differently impacted by the scandal. When the elasticity is normal, rural households will benefit. However, when the elasticity is high, which is very likely during the outbreak of a scandal, rural households will lose. Second, when fixed costs increase, rural households will lose. Third, when credit constraints for other rural households are relaxed due to subsidies from the government, other rural households will benefit while the poorest rural households lose due to decreasing factor incomes.

The real income of the poorest rural households decreases under nearly all the scenarios except when preferences for high standards dairy products increase while the Armington elasticity is normal. Hence, the government should pay due attention to the conditions of the poorest rural households while upgrading the dairy value chain.

Chapter 6. General Conclusions

This dissertation focuses on the relations between food standards and development. Chapter 2 shows that initial differences in income, capital and transaction costs – as well as the possibility of contracting between producers and processors – affect the emergence of and the size of the high standards economy. Chapter 3 shows that how poor rural households are affected by the expansion of the high standards sector depends on the nature of the shocks leading to the expansion of the high standards sector and on the existence and type of market imperfections, and whether the poor can gain through the labor market if they are excluded from high standards farming. Chapter 4 shows that the choice of processors which type of supplier to contract with depends on farmer type characteristics, more specifically on the farmer's efficiency and bargaining power. The weaker bargaining power of poor rural households increases profit transfers to the processor, and hence increases their probabilities of getting contracts and their income accordingly. Chapter 5 shows that during the 2008 tainted milk scandal and the subsequent reforms in China, poor rural households lose in nearly all the scenarios except when consumer preferences for high standards dairy products increase while increases in imports remain moderate.

The findings of this dissertation have several implications. First, both economic growth and institutions play a critical role for the inclusion of smallholders. Average income is a key determinant of the scale of the high standards food sector; production structures and contracting opportunities can induce the development of a high standards food sector; and transaction costs are also critically important in determining whether small farmers will or will not be included. Hence, economic growth as well as economic reforms, which may encourage private investment and decrease transaction costs, should be equally paid attention to. With capital market imperfections in developing countries, foreign companies often face less restrictive credit constraints than domestic companies and are therefore able to invest when it is not possible for domestic companies to do so.

Second, the expansion of the high standards food sector may affect rural households in several ways. They may expand their production of high standards products as the world price for high standards food increases, and as such raise their profits from high standards farming. Even though they may be excluded from product markets due to credit constraints, they may benefit from factor market effects. Furthermore, the spillover effects of growth in demand for high standards products on other product markets (in particular markets for low standards products) may reduce prices for products which are preferred by rural households.

Third, poor rural households will expand their production of high standards product with the increase of world price for high standards food. Expansion of high standards sector resulting from domestic preference changes may increase or decrease real incomes of poor rural households, and hence increases or decreases inequality (depending on whether HS production can compete with HS imports.). The effects are influenced by technology, required investment costs and factor market imperfections.

Therefore, in order to design appropriate policies, all these effects should be jointly taken into consideration. Overlooking some effects may lead to biased, and sometimes wrong, policy conclusions.

This dissertation provides several hypotheses for future empirical research projects. First, more research is needed to find out whether smallholders are actually included in and benefit from the expansion of the high standards sector and under which conditions our theoretical analysis indicate that farmers with a lower productivity may be excluded and hence lose the opportunity to benefit directly from the high standards sector. But they may benefit through the labor market. Second, while the representative ‘poorest rural’ households may benefit or lose as a group under scenarios we used, the distribution of benefits within this group has not been explored, which means that some ‘poorest rural’ households may benefit while others lose. All these issues offer fertile ground for future empirical research. A panel data set would be particularly useful to estimate which share of the earnings of farms in the modern channel is due to participation in the channel, and which share is attributable to intrinsic characteristics of the farmer which would allow him/her to have superior earnings even without entering the modern channel. Third, no empirical studies so far have analyzed the spillover effects on other markets which our model show to be very important.

There are also several issues which could benefit from further theoretical (and empirical) research. First, the assumed production structure in the general equilibrium framework may affect our results. Hence, future research may try to integrate the heterogeneous production structure in Chapter 2 into the general equilibrium model in Chapter 3 by following Melitz (2003) and Zhai (2008). Second, one could expect the models to include all the different actors in the value chains? My dissertation mainly focuses on the relation between farmers and processors. However, the relation between retailers, food industries and farmers is very important especially in the view of the ongoing supermarket revolution (Timmer, 2009). Since supermarkets play an increasingly important role in the food retail system and are often thought to have monopolistic power, farmers may improve their bargaining power by forming intermediate organizations, such as cooperatives. The formation of cooperatives and their impacts in an environment with strong involvement of supermarkets deserve more empirical and theoretical research. Third, the trade-off or competition between food security and food safety along with the implications for development calls for careful attention (Carvalho, 2006). Even though our general equilibrium model shows the spillover effect of an expanding high standards sector on prices of low standards food, these interactions need further exploration. Generally speaking, if development leads to increasing inequality in an initial stage, richer people may increase their demand for food safety while poorer people continue to focus their efforts on achieving food security. Since food safety and food security both compete for the same factor endowment of a country, the government has to strike a balance between these objectives when making policy decisions. Fourth, one could further distinguish between standards than we have done. For example, Anderson et al. (2004) argue that specific standards, such as genetically modified (GM) food standards are used as protection against imports, a conclusion disputed by recent findings of e.g., Swinnen and Vandemoortele (2008) and Marette and Beghin (2010). While developed countries have less incentives to adopt risky GM food, developing countries have more reasons for adoption. However, allowing GM food cultivation may negatively impact their opportunities to export to developed countries barring GM food (Vigani et al., 2010) and hence reduce their hope of developing through the use of innovative technologies. Our CGE model approach could provide an interesting extension of ongoing, mostly partial equilibrium, models.

References

Allen, D.W. and D. Lueck. (1998). The Nature of the Farm. *The Journal of Law and Economics* 41: 343-386.

Anderson, K., R. Damania and L.A. Jackson. (2004). Trade, Standards, and the Political Economy of Genetically Modified Food. *CEPR Discussion Papers* 4526.

Ando, A. and S.Takanori. (1997). A Multi-regional Model for China Based on Price and Quantity Equilibrium. in M. Chatterji, ed. *Regional Science Perspectives for the Future*, London MacMillan.

Bardhan, P. and Udry, C (1999). *Development Microeconomics*. New York: Oxford University Press Inc.

Barham, B.L., Boucher, S. and Carter, M.R. (1996). Credit Constraints, Credit Unions, and Small-Scale Producers in Guatemala. *World Development* 24: 793-806.

Besley, T., and M. Ghatak. (2007). Retailing Public Goods: The Economics of Corporate Social Responsibility. *Journal of Public Economics* 91: 1645-1663.

Bijman, J. (2008). Contract Farming in Developing Countries: An Overview. *Working Paper*. Wageningen University.

Birthal, P.S., P.K. Joshi and A. Gulati. (2005). Vertical Coordination in High-Value Food Commodities: Implications for Smallholders. *Discussion Paper* No. 85, Markets, Trade, and Institutions Division, International Food Policy Research Institute, Washington, D.C.

Braverman, A. and J. Stiglitz. (1982). Sharecropping and the Interlinking of Agrarian Markets. *American Economic Review* 72: 695-715.

Carter, M.R. (1988). Equilibrium Credit Rationing of Small Farm Agriculture. *Journal of Development Economics* 28:83–103.

Carter, M. R. and Mesbah, D. (1993). Can Land Market Reform Mitigate the Exclusionary Aspects of Rapid Agro-export Growth? *World Development* 21: 1085−1100.

Carvalho, F. (2006). Agriculture, Pesticides, Food Security and Food Safety. *Environmental Science & Policy* 9: 685-692.

Chen, S. and M. Ravallion. (2007). Absolute Poverty Measures for the Developing World, 1981-2004. *Proceedings of the National Academy of Sciences of the United States of America* 104: 16757-16762.

China Economy Yearbook Committee (CEYC). (2006). *China Economy Yearbook 2006*. Beijing: China Economy Yearbook Committee.

China National Bureau of Statistics (CNBS). (2006). *China Statistical Yearbook 2006*. Beijing: China Statistics Press.

China Ministry of Agriculture (CMA). (2006). *China Agriculture Yearbook 2006*. Beijing: China Agriculture Press.

Ciaian, P. and J. F.M. Swinnen. (2009). Credit Market Imperfections and the Distribution of Policy Rents. *American Journal of Agricultural Economics* 91: 1124–1139.

Ciaian, P., J. F.M. Swinnen, and W. Münch. (2002). The Impact of the Common Agricultural Policy on Income Distribution and Welfare in Central and Eastern European Countries. Lisbon: 5th International Workshop on European Economy.

Committee of Editing China Food Industry Yearbook (CECFIY). (2006). *China Food Industry Yearbook 2006*. China Statistics Press.

Copeland, B.R., and M.C. Taylor. (1995). Trade and Transboundary Pollution. *American Economic Review* 85: 716-737.

Cruz-Uribe, D. and C.J. Neugebauer (2002). Sharp Error Bounds for the Trapezoidal Rule and Simpson's Rule. *Journal of Inequalities in Pure and Applied Mathematics* 3: 1-22.

De Franco, M. and R. Godoy. (1993). Potato-Led Growth: The Macroeconomic Effects of Technological Innovations in Bolivian Agriculture. *Journal of Development Studies* 29: 561–87.

De Janvry, A., M. Fafchamps and E. Sadoulet. (1991). Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained. *The Economic Journal* 101: 1400-1417.

De Janvry, A. and E. Sadoulet. (2002). World Poverty and the Role of Agricultural Technology: Direct and Indirect Effects. *Journal of Development Studies* 38: 1-26.

Devarajan, S. and D. Rodrik. (1989). Trade Liberalization in Developing Countries: Do Imperfect Competition and Scale Economies Matter? *AER Papers and Proceedings*, 79: 283-287.

Dewatripont, M. and G. Michel. (1987). On Closure Rules, Homogeneity and Dynamics in Applied General Equilibrium Models. *Journal of Development Economics* 26: 65-76.

Dolan, C. and J. Humphrey. (2000). Governance and Trade in Fresh Vegetables: The Impact of UK Supermarkets on the African Horticulture Industry. *Journal of Development Studies* 37: 147-176.

Dries, L., E. Germenji, N. Noev and J.F.M. Swinnen. (2009). Farmers, Vertical Coordination, and the Restructuring of Dairy Supply Chains in Central and Eastern Europe. *World Development* 37: 1742-1758.

Dries, L., T. Reardon and J.F.M. Swinnen. (2004). The Rapid Rise of Supermarkets in Central and Eastern Europe: Implications for the Agrifood Sector and Rural Development. *Development Policy Review* 22: 525-556.

Dries, L. and J.F.M. Swinnen. (2004). Foreign Direct Investment, Vertical Integration and Local Suppliers: Evidence from the Polish Dairy Sector. *World Development* 32: 1525-1544.

Ellickson, P.B. (2006). Quality Competition in Retailing: A Structural Analysis. *International Journal of Industrial Organization* 24: 521– 540.

Enderwick, P. (2009). Avoiding quality fade in Chinese global supply chains: Designing appropriate governance structures. *Business Process Management Journal* 15: 876-894.

Eswaran, M. and A. Kotwal. (1985). A Theory of Two-tier Labor Markets in Agrarian Economies. *American Economic Review* 75: 162-177.

Faireclough, G. and L. Chao. (2008). Disclosure Failure Alleged: Formula Company, Chinese Officials Knew About Toxin. *The Wall Street Journal*.

Fan, S. and C. Chan-Kang. (2005). Is Small Beautiful? Farm Size, Productivity, and Poverty in Asian Agriculture. *Agricultural Economics* 32: 135−146.

Farina, E.M.M.Q. and T. Reardon. (2000). Agrifood Grades and Standards in the Extended Mercosur: Their Role in the Changing Agrifood System. *American Journal of Agricultural Economics* 82: 1170-1211.

Fischer, R. and P. Serra. (2000). Standards and Protection. *Journal of International Economics* 52: 377-400.

Francois, J.F. and D.W. Roland-Holst (1997). Scale Economies and Imperfect Competition. in Francois, J.F. and K.A. Reinert (eds). *Applied Methods for Trade Policy Analysis: A Handbook*, Cambridge: Cambridge University Press.

Fulponi, L. (2007). The Globalization of Private Standards and the Agri-food System. in J.F.M. Swinnen, ed. *Global Supply Chains, Standards and the Poor*, CABI Publishing.

Fulton, M. and K. Giannakis. (2004). Inserting GM Products into the Food Chain: The Market and Welfare Effects of Different Labeling and Regulatory Regimes. *American Journal of Agricultural Economics* 86: 42-60.

Gabszewicz, J.J. and J.-F. Thisse. (1979). Price Competition, Quality and Income Disparities. *Journal of Economic Theory* 20: 340-359.

Gale, F. and K. Huang. (2007). Demand for Food Quantity and Quality in China. *Economic Research Report*. No. 32. USDA.

Gangopadhyay, A. and K. Sengupata. (1987). Small Farmers, Moneylenders, and Trading Activity. *Oxford Economic Papers* 39: 333-342.

Gardner, B. (2003). U.S. Food Quality Standards: Fix for Market Failure or Costly Anachronism? *American Journal of Agricultural Economics* 85: 725-730.

Gelan, A. U. (2007). Does Food Aid Have Disincentive Effects on Local Production? A General Equilibrium Perspective on Food Aid in Ethiopia. *Food Policy* 32: 436-458.

Goldberg, P.K., and N. Pavcnik. (2007). Distributional Effects of Globalization in Developing Countries. *Journal of Economic Literature* 45: 39-82.

Gow, H.R., and J.F.M. Swinnen. (1998). Up- and Downstream Restructuring, Foreign Direct Investment, and Hold-up Problems in Agricultural Transition. *European Review of Agricultural Economics* 25: 331-350.

Gulati, A., N. Minot, C. Delgado and S. Bora. (2007). Growth in High-Value Agriculture in Asia and the Emergence of Vertical Links with Farmers. in J.F.M. Swinnen, ed. *Global Supply Chains, Standards and the Poor*, CABI Publishing.

Hallward-Driemeier, M., S. Wallsten and L. C. Xu. (2003). The Investment Climate and the Firm: Firm-Level Evidence from China. *World Bank Policy Research Working Paper*. No. 3003.

Harris, R. (1984). Applied General Equilibrium Analysis of Small Open Economies with Scale Economies and Imperfect Competition. *American Economic Review* 74: 1016-1032.

Hart, O. and B. Holmstrom (1986). The Theory of Contracts. in: T. Bewley, ed., *Advances in Economic Theory*. Cambridge University Press.

Henson, J.S. (2006). The Role of Public and Private Standards in Regulating International Food Markets. *Paper presented at the IATRC Symposium*. Bonn.

Henson, J.S., A.-M. Brouder, and W. Mitullah. (2000). Food Safety Requirements and Food Exports from Developing Countries: The Case of Fish Exports from Kenya to the European Union. *American Journal of Agricultural Economics* 82: 1159–1169.

Hertel, T. (1999). Applied General Equilibrium Analysis of Agricultural and Resource Policies. *Purdue University Staff Paper*, 99-2.

Hopenhayn, H. (1992). Entry, Exit, and Firm Dynamics in Long Run Equilibrium. *Econometrica* 60: 1127-1150.

Hu, D., T. Reardon, S. Rozelle, P. Timmer and H. Wang. (2004). The Emergence of Supermarkets with Chinese Characteristics: Challenges and Opportunities for China's Agricultural Development. *Development Policy Review* 22: 557-586.

Huang, J., Y. Wu, H. Zhi and S. Rozelle. (2008). Small Holder Incomes, Food Safety and Producing, and Marketing China's Fruit, *Review of Agricultural Economics* 30: 469-479.

Huang, J. and S. Rozelle. (2006). The Emergence of Agricultural Commodity Markets in China. *China Economic Review* 17: 266–280.

Huang, J., S. Rozelle and L. Zhang. (2000). WTO and Agriculture: Radical Reforms or the Continuation of Gradual Transition. *China Economic Review* 11: 397-401.

Humphrey, J., N. McCulloch and M. Ota. (2004). The Impact of European Market Changes on Employment in the Kenyan Horticulture Sector. *Journal of International Development* 16: 63-80.

Jaffee, S.M. and S. Henson. (2005). Agro-food Exports from Developing Countries: The Challenges Posed by Standards. in M.A. Aksoy and J.C. Beghin, ed. *Global Agricultural Trade and Developing Countries*, The World Bank, Washington D.C.: The World Bank.

Jin, S., J. Zhou and J. Ye. (2008). Adoption of HACCP System in the Chinese Food Industry: A Comparative Analysis. *Food Control* 19: 823-828.

Kancs, D. (2001). Predicting European Enlargement Impacts: A Framework of Interregional General Equilibrium. *Eastern European Economics* 39: 31-63.

Kancs, D. and P. Ciaian. (2010). Factor Content of Bilateral Trade: The Role of Firms Heterogeneity and Transaction Costs. *Agricultural Economics* 41: 305-317.

Keuschnigg, C, and E. Ribi. (2009). Outsourcing, Unemployment and Welfare Policy. *Journal of International Economics* 78: 168-176.

Key, N. and D. Runsten. (1999). Contract Farming, Smallholders, and Rural Development in Latin America: The Organization of Agroprocessing Firms and the Scale of Outgrower Production. *World Development* 27: 381-401.

Kilkenny, M. (1993). Rural/Urban Effects of Terminating Farm Subsidies. *American Journal of Agricultural Economics* 75: 968-980.

Konan, D.E. and A. Van Assche. (2007). Regulation, Market Structure and Service Trade Liberalization. *Economic Modelling* 24: 895-923.

Krugman, P. and A. Venables. (1995). Globalization and the Inequality of Nations. *Quarterly Journal of Economics* 110: 857-880.

Leland, H. (1979). Quacks, Lemons, and Licensing: A Theory of Minimum Quality Standards. *The Journal of Political Economy* 87: 1328-1346.

Lipton, M. (2001). Reviving Global Poverty Reduction: What Role for Genetically Modified Plants? *Journal of International Development* 13: 823-846.

Maertens, M., L. Colen and J.F.M. Swinnen. (2008). Globalization and Poverty in Senegal: A Worst Case Scenario? *LICOS Discussion Paper* No. 217. Leuven: LICOS.

Maertens, M. and J.F.M. Swinnen. (2009). Trade, Standards and Poverty: Evidence from Senegal. *World Development* 37: 161-178.

Marcoul, P. and L.P. Veysierre. (2008). A Financial Contracting Approach to the Role of Supermarkets in Farmers' Credit Access. *Working Paper.* Iowa State University.

Marette, S. and J. Beghin. (2010). Are Standards Always Protectionist? *Review of International Economics* 18: 179–192.

Mas-Colell, A., M. Whinston and J. Green. (1995). *Microeconomic Theory*. New York: Oxford University Press.

McCluskey, J. (2007). Public and Private Food Quality Standards: Recent Trends and Strategic Incentives. in J.F.M. Swinnen, ed. *Global Supply Chains, Standards and the Poor,* CABI Publishing.

Melitz, M. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica* 71: 1695 – 1725.

Mercenier, J. (1995). Nonuniqueness of Solutions in Applied General Equilibrium Models with Scale Economies and Imperfect Competition. *Economic Theory* 6: 161-177.

Ministry of Health of the People's Republic of China (MHPRC). (2006). *China Hygiene Statistic Yearbook 2006*. Beijing: Peking Union Medical College Press.

Minot, N. and M. Ngigi. (2004). Are Horticultural Exports a Replicable Success Story? Evidence from Kenya and Côte d'Ivoire. *EPTD/MTID Discussion Paper*, IFPRI, Washington, D.C.: IFPRI.

Minten, B., L. Randrianarison, and J.F.M. Swinnen. (2009). Global Retail Chains and Poor Farmers: Evidence from Madagascar. *World Development* 37: 1728−1741.

Miyata, S., N. Minot and D. Hu. (2009). Impact of Contract Farming on Income: Linking Small Farmers, Packers and Supermarkets in China. *World Development* 37: 1781-1790.

Moschini, G., L. Menapace, and D. Pick. (2008). Geographical Indications and the Competitive Provision of Quality in Agricultural Markets. *American Journal of Agricultural Economics* 90: 794–812.

Mussa, M. and S. Rosen. (1978). Monopoly and Product Quality. *Journal of Economic Theory* 18: 301–317.

Nash, J. F. (1950). The Bargaining Problem. *Econometrica* 21: 128-140.

Otsuki, T., J. S. Wilson. and M. Sewadeh. (2001). Saving Two in a Billion: Quantifying the Trade Effect of European Food Safety Standards on African Exports. *Food Policy* 26: 495–514.

People Bank of China (PBC) (2006). Operation Report of Chinese Regional Finance. (in Chinese) *Series of Report of Monetary Policy Execution of China*.

Pollak, R.A. (1985). A Transaction Cost Approach to Families and Households. *Journal of Economic Literature* 23: 581-608.

Ravallion, M. (2001). Growth, Inequality and Poverty: Looking Beyond Averages. *World Development* 29: 1803-1815.

Reardon, T., C.B. Barrett, J. A. Berdegue and J.F.M. Swinnen. (2009). Agrifood Industry Transformation and Small Farmers in Developing Countries. *World Development* 37: 1717−1727.

Reardon, T., J-M. Codron, L. Busch, J. Bingen and C. Harris. (2001). Global Change in Agrifood Grades and Standards: Agribusiness Strategic Responses in Developing Countries. *International Food and Agribusiness Management Review* 2: 421–435.

Reardon, T. and C.P. Timmer. (2005). Transformation of Markets for Agricultural Output in Developing Countries Since 1950: How Has Thinking Changed? in Evenson, R., P. Pingali and T.P. Schultz. eds., *Handbook of Agricultural Economics (Vol 3A): Agricultural Development: Farmers, Farm Production, and Farm Markets*. Holland: Elsevier.

Reardon, T., C.P. Timmer, C.B. Barrett and J. Berdegue. (2003). The Rise of Supermarkets in Africa, Asia, and Latin America. *American Journal Agricultural Economics* 85: 1140-1146.

Riskin, C. (2004). The Fall in Chinese Poverty: Issues of Measurement, Incidence and Cause. Keith Griffin Festschrift Conference at Political Economy Research Institute, University of Massachusetts, Amherst.

Rodrik, D. (1997). Why Is Trade Reform so Difficult in Africa? *Journal of African Economies* 7: 43-69.

Ronald-Holst, D.W., K.A. Reinert and C.R. Shiells. (1992). North American Trade Liberalization and the Role of Nontariff Barriers. In Economy-wide Modeling of the Economic Implications of a FTA with Mexico and a NAFTA with Canada and Mexico. Washington, DC: U.S. International Trade Commission.

Roe, B. and I. Sheldon. (2007). Credence Good Labeling: The Efficiency and Distributional Implications of Several Policy Approaches. *American Journal of Agricultural Economics* 89: 1020-1033.

Rozelle, S. and J.F.M. Swinnen, (2004). Success and Failure of Reform Insights from the Transition of Agriculture. *Journal of Economic Literature* 42: 404-456.

Savard, L. (2005). Poverty and Inequality Analysis within a CGE Framework: A Comparative Analysis of the Representative Agent and Microsimulation Approaches. *Development Policy Review* 23: 313-31.

Segura, F. S. (2006). Contract Farming in Costa Rica: Opportunities for Smallholders? *PhD Dissertation,* Holland: Wageningen University.

Shaked, A. and J. Sutton. (1982). Relaxing Price Competition Through Product Differentiation. *Review of Economic Studies* 49: 3-13.

Shaked, A. and J. Sutton. (1983). Natural Oligopolies. *Econometrica* 51: 1469-1483.

Shoven, J. and J. Whalley. (1992). *Applying General Equilibrium*. New York: Cambridge University Press.

Spence, A.M. (1975). Monopoly, Quality, and Regulation. *Bell Journal of Economics* 6: 417-429.

Spengler, J. J. (1950). Vertical Integration and Antitrust Policy. *The Journal of Political Economy* 58: 347-352.

St-Hilaire, F. and J. Whalley. (1983). A Microconsistent Equilibrium Data Set for Canada for Use in Tax Policy Analysis. *Review of Income and Wealth* 29: 175-204.

Stifel, C. and E. Thorbecke. (2003). A Dual-dual CGE Model of an Archetype African Economy: Trade Reform, Migration and Poverty. *Journal of Policy Modeling* 25: 207-235.

Stiglitz, J.E. and A. Weiss. (1981). Credit Rationing in Markets with Imperfect Information. *American Economic Review* 71: 393–410.

Stone, R. (1954). Linear Expenditure System and Demand Analysis: An Application to the Pattern of British Demand. *The Economic Journal* 64: 511-527.

Sutton, J. (2001). Rich Trades, Scarce Capabilities: Industrial Development Revisited. Keynes Lecture, Proceedings of the British Academy.

Swinnen, J.F.M. (2007). *Global Supply Chains, Standards and the Poor*. CABI publishing.

Swinnen, J.F.M. (2005). *When the Market Comes to You. Or Not. The Dynamics of Vertical Coordination in Agrifood Chains in Eastern Europe and Central Asia*. Washington D.C.: The World Bank.

Swinnen, J.F.M. and H.R. Gow. (1999). Agricultural Credit Problems and Policies During the Transition to a Market Economy in Central and Eastern Europe. *Food Policy* 24: 21-47.

Swinnen, J.F.M. and T. Vandemoortele. (2008). The Political Economy of Nutrition and Health Standards in Food Markets. *Review of Agricultural Economics* 30: 460-468.

Swinnen, J.F.M. and A. Vandeplas. (2007). Quality, Efficiency Premia, and Development. *LICOS Discussion Paper* No. 184. Leuven: LICOS.

Swinnen, J.F.M., A. Vandeplas and M. Maertens. (2009). Liberalization with Endogenous Institutions: A Comparative Analysis of Agricultural Reform in Africa, Asia, and Europe. *LICOS Discussion Paper*. No. 233. Leuven: LICOS.

Timmer, C. P. (2009). Do Supermarkets Change the Food Policy Agenda? *World Development* 37: 1812−1819.

Tirole, J. (1988). *The Theory of Industrial Organization*. Cambridge, MA: MIT Press.

Trefler, D. (1995). The Case of Missing Trade and Other Mysteries. *American Economic Review* 85: 1029-1046.

Trela, I., J. Whalley. and R. Wigle. (1987). International Trade in Grain: Domestic Policies and Trade Conflicts. *Scandinavian Journal of Economics* 89: 271-283.

Turrini, A. and T. Van Ypersele. (2002). Traders, Courts, and the Home Bias Puzzle. *Discussion Paper*. University of Bergamo.

Unnevehr, L. (2000). Food Safety Issues and Fresh Food Product Exports from LDCs. *Agricultural Economics* 23: 231-240.

Van Long, N., R. Riezman and A. Soubeyran. (2007). Trade, Wage Gaps, and Specific Human Capital Accumulation. *Review of International Economics* 15: 75–92.

Vandemoortele, T., S. Rozelle, J. F.M. Swinnen and T. Xiang. (2009). Quality and Inclusion of Small Producers in Value Chains: A Theoretical Note. *LICOS Discussion Paper* No. 246. Leuven: LICOS.

Vigani, M., V. Raimondi and A. Olper. (2010) GMO Regulations, International Trade and the Imperialism of Standards. *LICOS Discussion Paper* No. 255. Leuven: LICOS.

Von Braun, J., D. Hotchkiss and M. Immink. (1989). Non-traditional Export Crops in Guatemala: Effects on Production, Income, and Nutrition. *Research Report* 73. Washington: IFPRI.

Wang, H., X. Dong, S. Rozelle, J. Huang and T. Reardon. (2009). Producing and Procuring Horticultural Crops with Chinese Characteristics: The Case of Northern China. *World Development* 37: 1791-1801.

Wang, Z. and E. Schuh. (2002). The Emergence of a Greater China and Its Impact on World Trade: A Computable General Equilibrium Analysis. *Journal of Comparative Economics* 30: 531-566.

Waschik, R. and I. Fraser. (2007). A Computable General Equilibrium Analysis of Export Taxes in the Australian Wool Industry. *Economic Modelling* 24: 712-736.

Weatherspoon, D.D., J. Cacho and R. Christy. (2001). Linking Globalization, Economic Growth and Poverty: Impacts of Agribusiness Strategies on Sub-Saharan Africa. *American Journal of Agricultural Economics* 83: 722-729.

Weatherspoon, D.D. and T. Reardon. (2003). The Rise of Supermarkets in Africa: Implications for Agrifood Systems and the Rural Poor. *Development Policy Review* 21: 333-356.

Weinberger, K. and T.A. Lumpkin. (2007). Diversification into Horticulture and Poverty Reduction: A Research Agenda. *World Development* 35: 1464−1480.

Willenbockel, D. (2004). Specification Choice and Robustness in CGE Trade Policy Analysis with Imperfect Competition. *Economic Modelling* 21: 1065-1099.

Williamson, O. (1985). *The Economic Institutions of Capitalism*. New York: The Free Press.

World Bank. (2009). From Poor Areas to Poor People: China's Evolving Poverty Reduction Agenda ---- An Assessment of Poverty and Inequality. in *China, Poverty Reduction and Economic Management Department Report*. Washington D.C.: The World Bank.

World Bank. (2005a). Food Safety and Agricultural Health Standards: Challenges and Opportunities for Developing Country Exports. *Poverty Reduction and Economic Management Trade Unit and Agricultural and Rural Development Department*, Report No. 31207. Washington D.C.: The World Bank.

World Bank. (2005b). The Dynamics of Vertical Coordination in Agrifood Chains in Eastern Europe and Central Asia. *Implications for Policy Making and World Bank Operations*. Washington D.C.: The World Bank.

Xiang, T., J. Huang, D. Kancs, S. Rozelle and J.F.M. Swinnen. (2010). Food Standards and Welfare: A General Equilibrium Model with Market Imperfections. *LICOS Discussion Paper* No. 263. Leuven: LICOS.

Xinhua Net. (2008). Rolling Report on Sanlu Babies and Infants Milk Powder Event (in Chinese). http://news.xinhuanet.com/newscenter/2008-09/12/content_9935963.htm accessed on March 1, 2009.

Zhai, F. (2008). Armington Meets Melitz: Introducing Firm Heterogeneity in a Global CGE Model of Trade. *Journal of Economic Integration* 23: 575- 604.

Zhao, Y. (1999). Labor Migration and Earnings Differences: The Case of Rural China. *Economic Development and Cultural Change* 47: 767-782.

Appendix.

A. Data for Chapter 3

The structure and characteristics of China's economy are shown in Table 3.2. The System of National Accounts and its related data sets for China provide the starting point for our dataset of 2005, which is also the latest available dataset. Most data are collected from China Statistics Yearbook (CNBS, 2006). For those that can't be found from the yearbook, we complement from other sources, like China Agriculture Yearbook (CMA, 2006) and the Input/output Table 2002.[57]

Essentially the procedure required to produce our data set involves extensions, modifications and redefinitions of concepts for portions of the national accounts data; the addition of further detail to this system; and final adjustments between blocks of data in order to restore mutual consistency. As we have stated that the concept of standards includes so many aspects that we cannot differentiate exactly which food belongs to high standards or not. Hence, we only make some approximation to describe a rough figure.

A.1. Production

GDP is 18.67 trillion Yuan and divided into the final commodity sectors: low and high standards food, and the other commodity sector. The shares of rural households and corporate farms in the high standards farming are estimated according to their farming areas.

The parameters in production functions are determined by using either cost/revenue table or the input/output table according to the availability of data. The cost/revenue tables for the agriculture are used to calculate the contribution rates of

[57] The input/output tables of China are edited once per five years. The Input/output Table 2002 is, hence, the latest available table.

low and high standards farming under our following assumption: Since the profit rate of contract farming is larger than that of non-contract farming from the sample data of Miyata et al. (2009), the difference (11.2%) is treated as the positive profit for high standards farming in our case. And we proxy the input/output of both high standards and low standards intermediate product by the weighted average of agricultural products including wheat, maize, rice tobacco, tea, peanut, sugar cane, beet and apple, etc. The contribution rates of factors in the processing sector are calculated from the Input/output Table 2002 (CNBS, 2006). The labor wages, amortization and intermediate input of construction sector are proxies of contributions of labor, capital and land. The wages in processing and industrial sectors are divided into rural and urban labor according to the aggregate ratio of rural to urban labor revenues.

A.2. Household Income, Savings/Investment and Consumption

From the expenditure side, GDP is divided into consumption, investment and net export. All the aggregate amounts can be found in the GDP structure from the yearbook. The disaggregate data of households are collected from the income and expenditure structures of individual households.

The investment and net export are added up to the amount of savings. The individual household savings are calculated as income less consumption. However, the calculated saving rates seem too low, probably because of lack of treatment of government and corporate savings, and are enlarged to suit the aggregate saving amount according to their relative shares. The investments are sorted into the final commodity sectors according to their shares in input/output table.

The division of income between rural[58] and urban households is based on the income per capita and ratio of population. The consumption structures are calculated from the expenditure of households. Engel indices are used to divide food and non-food consumptions. The expenditure on food is divided into consumptions of low and high standards food. The poorest rural households and urban households are assumed to consume the largest shares of low standards food (99.9%) and high standards food (6.7%) respectively. The consumption ratios of the other rural households are calculated by inserting numbers proportionally so that the overall consumption is equal to production minus investment.

As far as the household income structures are concerned, the yearbook only divides income data into four parts: Income from wages and salaries, from household operations, from properties, and from transfers. The divisions among these items of income are not very clear and can't be easily sorted into factor income and profit. We deal with them as follows: Income from wages and salaries is treated as wages and income from properties as capital income straightforwardly. Income from transfers is excluded since there is no government in our model. The most important income for rural households is the income from household operations. It is sorted into profit and factor incomes, including those from labor, from land and from capital, which are added into other factor incomes to get the final income structures of rural households. Even though the statistical income from operations includes other activities, like transportation, we use its total amount as proxy to farming operations since we cannot

[58] Rural Households, according to the explanation of the yearbook, refer to usual resident households in rural areas. 'Usual resident households in rural areas are households residing on a long term basis(for more than one year) in the areas under the administration of township governments (not including county towns), and in the areas under the administration of villages in county towns. Households residing in the current addresses for over one year with their household registration in other places are still considered as resident households of the locality. For households with their household registration in one place but all members of the households having moved away to make a living in another place for over one year, they will not be included in the rural households of the area where they are registered, irrespective of whether they still keep their contracted land.' (CNBS, 2006)

differentiate them. As for urban households, its income from wages and salaries is treated as income from labor. And the incomes from household operations and from properties are added up to income from capital.[59]

Because of transportation cost of migration between rural and urban regions, the wages earned in the two regions are different. The gap between wage of rural labor working in urban region (8520 Yuan according to PBC (2006)) and average income per labor in rural region (6948 Yuan) [60] is treated as the iceberg costs. The implicit assumption under the use of income per rural labor as the base of comparison is that rural laborer makes the decision of migration by comparing that income with wage in urban region.

A.3. External Sector

All final commodities are tradable and have both export and import.

A.4. 'RAS' Adjustments[61]

After the adjustments, modifications and additions listed above are completed, the remaining inconsistencies in our data set involve major data blocks which need to be realigned so as to satisfy (or restore in certain cases) equilibrium conditions.

In the 'RAS' procedure a non-negative matrix which does not initially meet prescribed non-negative row and column sum constraints is restored to a situation of consistency through a sequence of alternating operations on rows and columns of the matrix. First row constraints are satisfied, then column constraints, then row constraints, and so on until a consistent matrix is achieved. The sums of prespecified

[59] Even though the migrants from rural to urban may keep their rights in the rural land, we don't count it in because of the unavailability of data.

[60] Because all the incomes earned by rural households are attached to their operations in rural activities, they are the best alternative choice to wages earned in urban area.

[61] This method is referred to St-Hilaire and Whalley (1983).

row and column constraints must be the same since they both provide the matrix sum. If the matrix is everywhere dense, convergence is assured.

After the ‘RAS’ procedure, the GDP as a whole only increases 0.7%. The largest modification is to decrease the consumption of high standards food for urban households by 57.8%. This may be a signal that we have no precise data on high standards food consumption and that high standards food consists of a very small part of the whole economy and is more vulnerable to change. Considering the limited data availability against intensive use of data, such scale of data modification is thought to be acceptable.

B. Sensitivity Analyses for Chapter 3

In order to assess the robustness of our results we perform sensitivity analysis of the key assumptions.[62] First, our results are robust to alternative assumptions on income elasticities of low standards products ($\varsigma^{RP} \in (1.35,\ 0.9,\ 0.45)$ for the poorest rural households, and structural modification of elasticities for the other households).

Second, alternative choices of the elasiticities of transformation ($\sigma_{LF}{}^{t} \in (0.6,\ 1.2, 1.8)$, $\sigma_{HF}{}^{t} \in (0.6,\ 1.2, 1.8)$ and $\sigma_{O}{}^{t} \in (0.4,\ 0.8,\ 1.2)$) and the elasticities of substitution ($\sigma_{LF}{}^{q} \in (1.5,\ 3.0, 4.5)$, $\sigma_{HF}{}^{q} \in (1.5,\ 3.0, 4.5)$ and $\sigma_{O}{}^{q} \in (0.25,\ 0.5,\ 0.75)$) yield only marginal changes to our comparative static results in the simulations of trade and credit constraints, while they have some impacts on the simulations of preference changes. The reason why the simulation results of preference change are sensitive to different assumptions of elasticities in trade lies in the fact that higher values of elastisities of substitution between domestic and foreign markets will benefit those consumers and producers who are highly involved in the outward-oriented sector.

Third, alternative choices of the substitution elasticities between factors ($\sigma_{R}{}^{s} \in (0.35,\ 0.7,\ 1.05)$, $\sigma_{po}{}^{s} \in (0.075,\ 0.15,\ 0.225)$, $\sigma_{PS}{}^{s} \in (0.4,\ 0.8,\ 1.2)$ and $\sigma_{O}{}^{s} \in (0.45,\ 0.9,\ 1.35)$) yield only small changes in the results for the simulations of trade and credit constraints. They do have some significant impacts on the simulations of preference changes. But the signs of the effects do not change. For example, increasing these substitution elasticities will decrease the income of the poorest rural households more (from -0.09% to -0.13%), decrease the income of the other rural

[62] A full set of sensitivity analyzes results is available from the authors upon request.

households less (from -0.16% to -0.15%) and increase the income of urban households less (from +0.31% to +0.29%).

In summary, our results are robust to variations in all these parameters.

C. Data for Chapter 5

The basic structure of SAM has been formed in Chapter 4. We supplement it with data on the dairy sector. The sources are the public yearbooks of the dairy sector and our survey carried out in 2009. The main changes are the input/output structure of the high standards farming sector, the share of this sector and the trade in this sector, etc.. The main modifications are shown as follows.

C.1. Production

The total output value for the dairy sector is 59.79 billion Yuan. We assume 20% of it satisfies relatively high standards. Thus, the high standards dairy sector has a scale of 11.96, about 0.5% of the total value of agricultural raw material. The shares of rural households and corporate farms in the high standards dairy sector are calculated according to their output. The poorest rural households, other rural households and the corporate farms are assumed to produce 10%, 80% and 10% of the whole output. The input/output data for the dairy sector is not available. We stick to the previous input/output data for high standards farming. Since the profit rate of dairy is larger than other agricultural sectors, we set the profit rate as 19.5% (CDA, 2006).

C.2. Household Consumption

The yearbook only provides per capita consumption for rural and urban households. We decompose the rural consumption by assuming that the poorest rural households consume only 0.5 kg per capita per year. And then the other rural households consume 1.4 kg per capita per year.

C.3. External Sector

The trade in dairy sector is regarded as the trade in high standards dairy sector since almost all tradable dairy products are high standards products. The data include all the dairy products such as liquid milk, milk powder and dry milk, etc..

Figure A3.1 Export-led Expansion with Different Income Elasticities

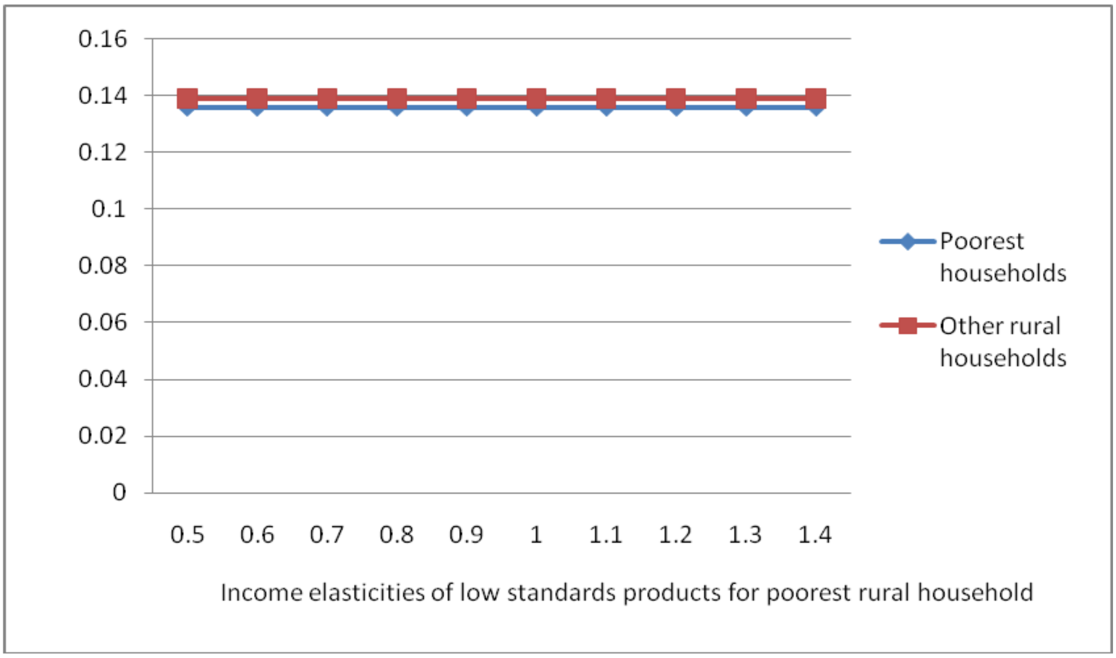


Figure A3.2 Export-led Expansion with Different Amington Elasticities

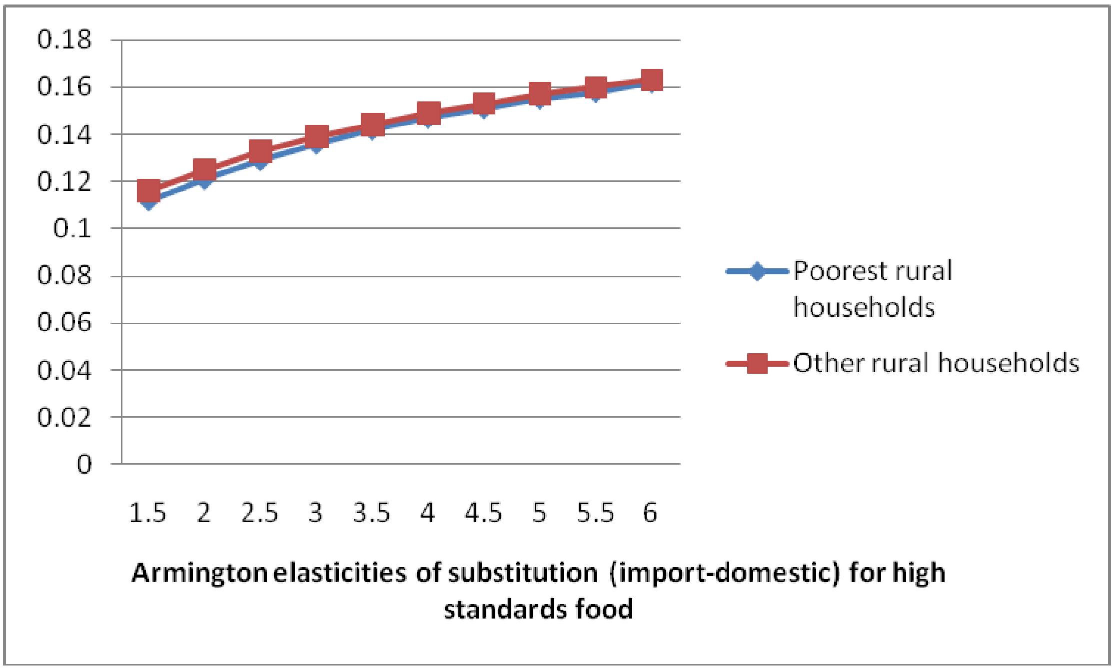


Figure A3.3 Domestic Demand Growth with Different Substitution Elasticities

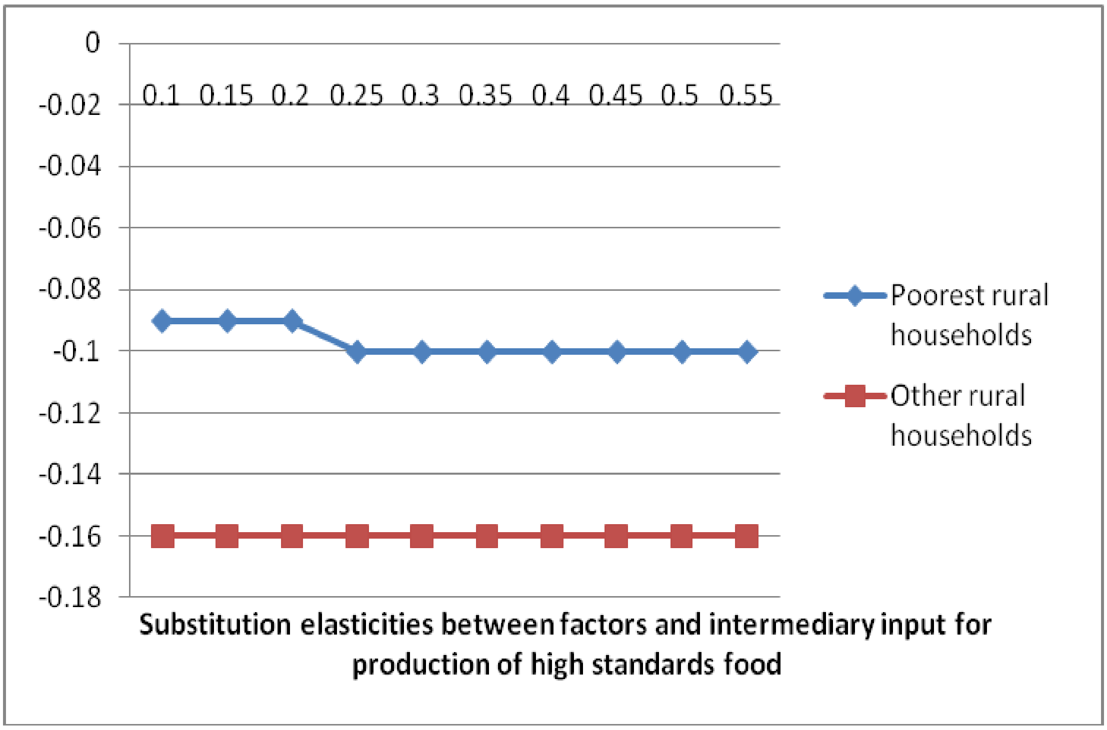


Figure A3.4 Domestic Demand Growth with Different Elasticities of Transformation

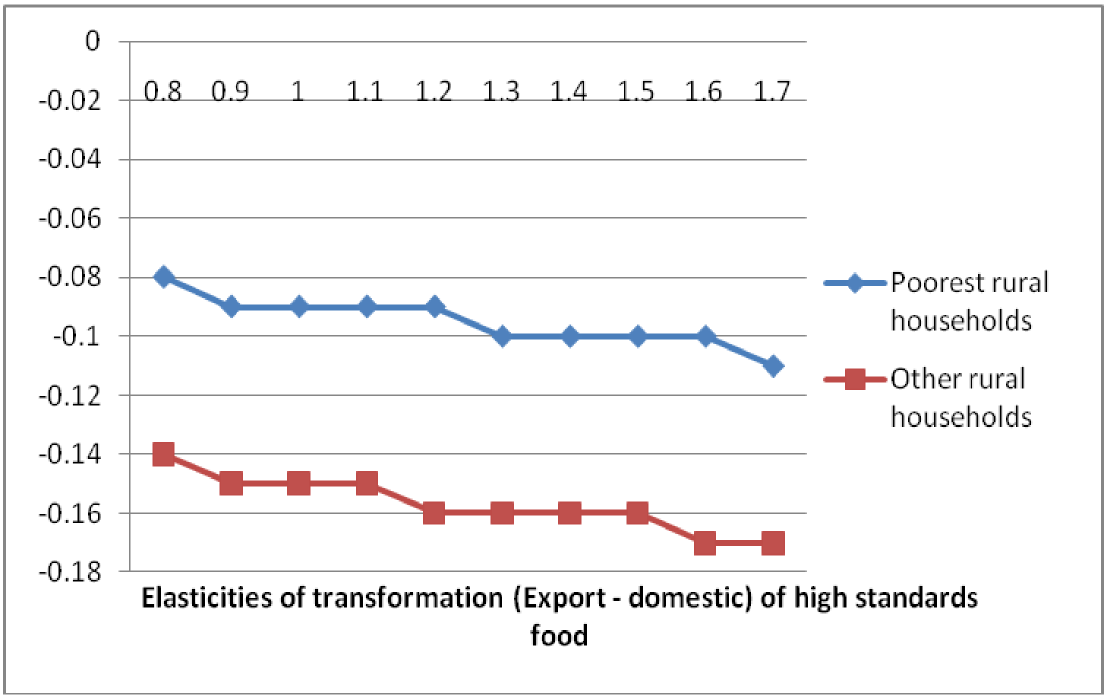
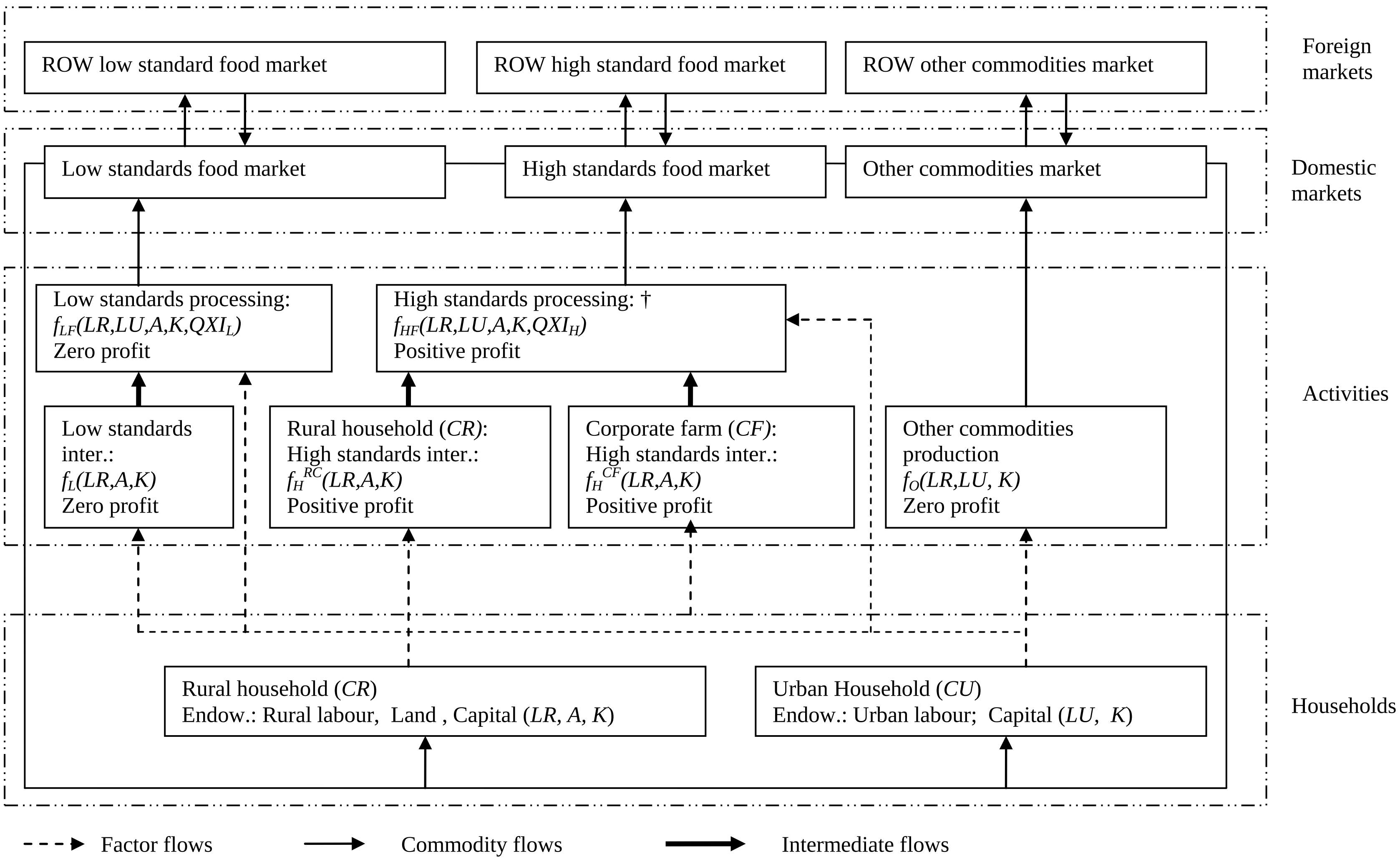


Figure A4.1 Modified CGE Model Structure



Note: Difference from Figure 3.1 is shown by †.

Table A3.1 The Model

Production and factor demand

$QX_b = \phi_b CES(LR_b, A_b, K_b)$ (A1)

$QX_O = \phi_O CES(\phi_{OL} CD(LR_O, LU_O), K_O)$ (A 2)

$QX_{po} = \phi_{po} CES(\phi_{poS} CES(\phi_{poL} CD(LR_{po}, LU_{po}), A_{po}, K_{po}), QXI_{po})$ (A 3)

$K_H^c = \kappa^c r^{\varepsilon^c}, c \in CR \bigcup CF$ (A 4)

$LR_L = LR_L^*(PX_L, wr_R, t, r)$ (A 5)

$LR_H^c = LR_H^{c\,*}(PX_H, wr_R, t; K_H^c), c \in CR \bigcup CF$ (A 6)

$Ll_{po} = Ll_{po}^*(wr_R, wu, t, r, PXI_{po})$ (A 7)

$Ll_O = Ll_O^*(PX_O, wr_U, wu, r)$ (A 8)

$A_L = A_L^*(PX_L, wr_R, t, r)$ (A 9)

$A_H^c = A_H^{c\,*}(PX_H, wr_R, t, r; K_H^c), c \in CR \bigcup CF$ (A 10)

$A_{po} = A_{po}^*(wr_R, wu, t, r, PXI_{po})$ (A 11)

$K_L = K_L^*(PX_L, wr_R, t, r)$ (A 12)

$K_{po} = K_{po}^*(wr_R, wu, t, r, PXI_{po})$ (A 13)

$K_O = K_O^*(PX_O, wr_U, wu, r)$ (A 14)

$X_{po} = X_{po}^*(wr_R, wu, t, r, PXI_{po})$ (A 15)

Income and demand

$\prod^c = PX_H f_H(LR_H^c, A_H^c, K_H^c) - wr_R(LR_H^c + \varphi^c) - tA_H^c - r(K_H^c + \psi^c), c \in CR \bigcup CF$ (A 16)

$$Y^c = \begin{cases} wr_R LR^c + tA^c + rK^c + \prod^c + \gamma^c \prod^{CF}, & c \in CR \\ wuLU^c + rK^c + \gamma^c \prod^{CF}, & c \in CU \end{cases} \quad \text{(A 17)}$$

$$X_{HF}{}^c = \frac{a_{HF}^c (1 - mps^c) Y^c}{PQ_{HF}} - a_{LF}^c \zeta^c, c \in C \quad \text{(A 18a)}$$

$$X_{LF}{}^c = \frac{a_{LF}^c (1 - mps^c) Y^c}{PQ_{LF}} + \frac{PQ_{HF}}{PQ_{LF}} a_{LF}^c \zeta^c, c \in C \quad \text{(A 18b)}$$

$$X_O{}^c = \frac{(1 - a_{LF}^c - a_{HF}^c)}{PQ_O} (1 - mps^c) Y^c, c \in C \quad \text{(A 18c)}$$

Subject to the household budget constraint:

$$\sum_{m \in M} PQ_m \bullet X_m^c = (1 - mps^c) Y^c, c \in C$$

Savings and investment

$S^c = mps^c * Y^c, c \in C$ (A 19)

$QINV_m = qinv_m * IADJ$ (A 20)

$$FSAV + \sum_{m \in M} PQ_m * QINV_m = \sum_{c \in C} mps^c * Y^c \quad \text{(A 21)}$$

Foreign trade

$QQ_m = aq_m CES(QM_m, QD_m)$ (A 22)

$QX_m = at_m CET(QE_m, QD_m)$ (A 23)

$$\frac{QQ_m}{QD_m} = \left(\frac{PD_m}{QM_m} * \frac{\delta_m{}^q}{1 - \delta_m{}^q}\right)^{1/(1+\sigma_m{}^q)} \quad \text{(A 24)}$$

$$\frac{QE_m}{QD_m} = \left(\frac{PE_m}{PD_m} * \frac{1 - \delta_m{}^t}{\delta_m{}^t}\right)^{1/(\sigma_m{}^t - 1)} \quad \text{(A 25)}$$

$PM_m = pwm_m * EXR$ (A 26)

$PE_m = pwe_m * EXR$ (A 27)

$PQ_m * QQ_m = PD_m * QD_m + PM_m * QM_m$ (A 28)

$$PX_m * QX_m = PD_m * QD_m + PE_m * QE_m \tag{A 29}$$

$$CPI = \sum_m v_m * PQ_m \tag{A 30}$$

$$PPI = \sum_m \mu_m * PI_m \tag{A 31}$$

Equilibrium conditions

(a) *Demands equal supply for factors*

$$\sum_{i \in B} LR_i^* + \sum_{po} LR_{po}^* + LR_U^* / \tau + \sum_{c \in CR \cup CF} \varphi^c = \sum_{c \in CR} L^c \tag{A 32}$$

$$\sum_m LU_m^* = L^U \tag{A 33}$$

$$\sum_{i \in B} A_i^* + \sum_{po} A_{po}^* = \sum_{c \in C} A^c \tag{A 34}$$

$$K_L^* + \sum_{c \in CR \cup CF} K_H^c + \sum_{po} K_{po}^* + K_O^* + \sum_{c \in CR \cup CF} \psi^c = \sum_{c \in C} K^c \tag{A 35}$$

(b) *Demands equal supply for goods*

$$\sum_c X_m^{c*} + QINV_m = QQ_m \tag{A 36}$$

$$X_{po} = QXI_{po} \tag{A 37}$$

(c) *Current account balance for ROW (in domestic currency)*

$$\sum_m PE_m * QE_m = \sum_m PM_m * QM_m + FSAV \tag{A 38}$$

Endogenous variables

wr_R, wr_U, wu, t, r	Price of factors
PX_i	Producer price of activity *i*
PXI_{po}	Producer price of intermediate product
PQ_m	Price of composite good
PD_m	Price of domestically produced good for domestic market
PE_m	Export price in domestic currency
$\prod^c$	Profit for high standards farming to agent *c*
γ^c	Endogenous share parameters of transferred profit from corporate farms
LR_i, LU_i, A_i, K_i	Demand of factor from activity *i*
X_{po}	Demand of intermediate input from processing sector *po*
X_m^{c*}	Consumption of commodity *m* by households *c*
QX_i	Domestic production
QXI_{po}	Production of intermediate input in processing sector *po*
QQ_m	Domestic demand for composite good
QD_m	Domestic demand for domestically produced good
QE_m	Export
Y^c	Income of households *c*
YF_b^c	Factor income of households *c* from factor *b*
$IADJ$	Investment adjustment factor
$QINV_m$	Quantity of investment demand for commodity *m*
CPI	Aggregate consumer price
PPI	Aggregate producer price

Exogenous variables and coefficients

ϕ_i	Efficient parameter of activity *i* for different level of nests

$\kappa^c, c \in CR \bigcup CF$	Collateral of agent *c* in high standards farming
a_m^c	Share parameter of household consumption spending on commodity *m*
pwe_m	Export price for *m* (foreign currency)
pwm_m	Import price for *m* (foreign currency)
ν_m	Weight of commodity *m* in the CPI
μ_m	Weight of commodity *m* in the PINDEX
LR^c, LU^c, A^c, K^c	Household endowment
τ	Migration cost rate
mps^c	Marginal (and average) propensity to save for households *c*
$qinv_m$	Baseline quantity of fixed investment demand
$\sigma_m{}^q$	Armington elasticities of substitution
$\sigma_m{}^t$	Elasticities of transformation
φ^c	Fixed costs in the form of rural labor
ψ^c	Fixed costs in the form of capital
FSAV	Foreign savings (domestic currency)

Numeraire

EXR	Exchange rate (dom. Currency per unit of for. Currency)

Functions

CES	Constant elasticity of substitution function
CD	Cobb-Douglas function
CET	Constant elasticity of transformation function

Indices and sets

i	Index for activities, $i \in I$
b	Index for intermediate sectors $b \in B = L \bigcup H$
po	Index for processing sectors $po \in LF \bigcup HF$
j	Index for factors, $j \in J$
l	Index for labor categories, $l = LR \cup LU$
c	Index for agents, $c \in C \bigcup CO$
m	Index for commodities, $m \in M$

Table A3.2 Export-led Expansion under Different Technologies
($\Delta pwe_{HF} / pwe_{HF} = +25\%$ and $\Delta pwm_{HF} / pwm_{HF} = +25\%$ **)**

Sim 3A: 15% of the baseline labor is used in high standards farming.
Sim 3B: 150% of the baseline labor is used in high standards farming.

	Sim 3A	Sim 3B
Aggregate effects		
Real GDP	-0.04	-0.05
CPI	0.46	0.52
Gini coefficient	-0.25	-0.31
Consumptions		
Low standards food	0.64	0.53
High standards food	-60.87	-53.69
Other commodities	0.04	0.05
Output of final commodities		
Low standards food	0.52	0.39
High standards food	3.15	22.44
Other commodities	-0.11	-0.13
Individual output of high standards intermediate product		
Poorest rural households	2.07	18.04
Other rural households	2.77	22.22
Corporate farms	3.02	22.10
Trade		
Import volume		
Low standards food	2.59	2.75
High standards food	-79.09	-75.14
Other commodities	0.23	0.26
Export volume		
Low standards food	-0.23	-0.47
High standards food	22.93	47.05
Other commodities	-0.39	-0.45
Rural labor used in high standards intermediate product		
Poorest rural households	8.92	25.78
Other rural households	9.65	30.23
Corporate farms	9.92	30.11
Domestic consumer price		
Low standards food	0.64	0.73
High standards food	1.67	1.58
Other commodities	0.37	0.43
Company food price		
Low standards food	0.63	0.72
High standards food	7.34	7.30
Other commodities	0.35	0.40
Farm gate price		
Low standards intermediate product	0.65	0.75
High standards intermediate product	10.26	10.17
Factor price		
Rural labor	0.50	0.62
Urban labor	0.26	0.29
Land	1.46	1.63
Capital	0.43	0.45
Poorest rural households		
Profit effect from high standards farming	0.03	0.03

Profit sharing from corporate farm	0.00	0.00
Factor income effect	0.08	0.13
Among it:		
Labor	-0.00	0.04
Land	0.08	-0.02
Total income effect	0.11	0.17
Other rural households		
Profit effect from high standards farming	0.03	0.03
Profit sharing from corporate farm	0.00	0.00
Factor income effect	0.09	0.12
Among it:		
Labor	0.01	0.04
Land	0.08	0.09
Capital	-0.01	-0.01
Total income effect	0.12	0.16
Urban households		
Profit sharing from corporate farm	0.00	0.00
Factor income effect	-0.14	-0.16
Among it:		
Labor	-0.13	-0.15
Capital	-0.00	-0.00
Total income effect	-0.14	-0.16

Table A3.3 Domestic Growth Expansion under Different Technologies ($\Delta\zeta^U / \zeta^U = -25\%$)

Sim 4A: 15% of the baseline labor is used in high standards farming.
Sim 4B: 150% of the baseline labor is used in high standards farming.

	Sim 4A	Sim 4B
Aggregate effects		
Real GDP	0.15	0.18
CPI	-1.02	-1.18
Gini coefficient	0.50	0.52
Output of final commodities		
Low standards food	-1.62	-2.43
High standards food	6.26	59.78
Other commodities	0.32	0.35
Individual output of high standards intermediate product		
Poorest rural households	4.42	48.01
Other rural households	5.12	59.01
Corporate farms	4.68	57.64
Trade		
Import volume		
Low standards food	-6.29	-7.74
High standards food	247.51	319.05
Other commodities	-0.49	-0.57
Export volume		
Low standards food	0.19	-0.36
High standards food	-15.29	33.75
Other commodities	0.96	1.09
Rural labor used in high standards intermediate product		
Poorest rural households	10.55	66.68
Other rural households	25.00	83.29
Corporate farms	21.73	80.88
Domestic consumer price		
Low standards food	-1.52	-1.75
High standards food	11.04	9.23
Other commodities	-0.85	-0.98
Company food price		
Low standards food	-1.51	-1.73
High standards food	20.79	15.97
Other commodities	-0.79	-0.91
Farm gate price		
Low standards intermediate product	-1.56	-1.78
High standards intermediate product	30.33	23.48
Factor price		
Rural labor	-1.20	-1.23
Urban labor	-0.53	-0.61
Land	-3.39	-3.99
Capital	-1.04	-1.30
Poorest rural households		
Profit effect from high standards farming	0.11	0.11
Profit sharing from corporate farm	0.00	0.01
Factor income effect	-0.24	-0.15
Among it:		
Labor	-0.04	0.09
Land	-0.20	-0.24

Total income effect	-0.13	-0.04
Other rural households		
Profit effect from high standards farming	0.11	0.11
Profit sharing from corporate farm	0.00	0.01
Factor income effect	-0.27	-0.27
Among it:		
Labor	-0.07	0.01
Land	-0.21	-0.25
Capital	0.01	-0.02
Total income effect	-0.16	-0.15
Urban households		
Profit sharing from corporate farm	0.00	0.01
Factor income effect	0.29	0.33
Among it:		
Labor	0.31	0.38
Capital	-0.02	-0.05
Total income effect	0.29	0.33

Table A4.1 The Modified CGE Model

Production and factor demand

$$QX_b = \phi_b CES(LR_b, A_b, K_b) \quad \text{(A1)}$$

$$QX_O = \phi_O CES(\phi_{OL} CD(LR_O, LU_O), K_O) \quad \text{(A 2)}$$

$$QX_{po} = \phi_{po} CES(\phi_{poS} CES(\phi_{poL} CD(LR_{po}, LU_{po}), A_{po}, K_{po}), QXI_{po}) \quad \text{(A 3)}$$

$$K_H^c = \kappa^c r^{\varepsilon^c}, c \in CR \cup CF \quad \text{(A 4)}$$

$$LR_L = LR_L^{*}(PX_L, wr_R, t, r) \quad \text{(A 5)}$$

$$LR_H^c = LR_H^{c\,*}(PX_H, wr_R, t; K_H^c), c \in CR \cup CF \quad \text{(A 6)}$$

$$Ll_{LF} = Ll_{LF}^{*}(PX_{LF}, wr_R, wu, t, r, PXI_{LF}) \quad \text{(A 7)}$$

$$Ll_{HF} = Ll_{HF}^{*}(AC_{HF}, wr_R, wu, t, r, PXI_{HF}) \quad \text{(A 8) †}$$

$$Ll_O = Ll_O^{*}(PX_O, wr_U, wu, r) \quad \text{(A 9)}$$

$$A_L = A_L^{*}(PX_L, wr_R, t, r) \quad \text{(A 10)}$$

$$A_H^c = A_H^{c\,*}(PX_H, wr_R, t, r; K_H^c), c \in CR \cup CF \quad \text{(A 11)}$$

$$A_{LF} = A_{LF}^{*}(PX_{LF}, wr_R, wu, t, r, PXI_{LF}) \quad \text{(A 12)}$$

$$A_{HF} = A_{HF}^{*}(AC_{HF}, wr_R, wu, t, r, PXI_{HF}) \quad \text{(A 13) †}$$

$$K_L = K_L^{*}(PX_L, wr_R, t, r) \quad \text{(A 14)}$$

$$K_{LF} = K_{LF}^{*}(PX_{LF}, wr_R, wu, t, r, PXI_{LF}) \quad \text{(A 15)}$$

$$K_{HF} = K_{HF}^{*}(AC_{HF}, wr_R, wu, t, r, PXI_{HF}) \quad \text{(A 16) †}$$

$$K_O = K_O^{*}(PX_O, wr_U, wu, r) \quad \text{(A 17)}$$

$$X_{LF} = X_{LF}^{*}(PX_{LF}, wr_R, wu, t, r, PXI_{LF}) \quad \text{(A 18)}$$

$$X_{HF} = X_{HF}^{*}(AC_{HF}, wr_R, wu, t, r, PXI_{HF}) \quad \text{(A 19) †}$$

$$(PXI_{poH} - AC) / PXI_{poH} = 1/\varepsilon_{poH} \quad \text{(A 20) †}$$

Income and demand (A 21)

$$\prod^c = PX_H f_H(LR_H^c, A_H^c, K_H^c) - wr_R(LR_H^c + \varphi^c) - tA_H^c - r(K_H^c + \psi^c), c \in CR \cup CF$$

$$\prod^{poH} = (PXI_{poH} - AC) QX_{poH} \quad \text{(A 22) †}$$

$$Y^c = \begin{cases} wr_R LR^c + tA^c + rK^c + \prod^c + \gamma^c \prod^{CF} + \beta^c \prod^{poH}, & c \in CR \\ wuLU^c + rK^c + \gamma^c \prod^{CF} + \beta^c \prod^{poH}, & c \in CU \end{cases} \quad \text{(A 23) †}$$

$$X_{HF}{}^c = \frac{a_{HF}^c (1 - mps^c) Y^c}{PQ_{HF}} - a_{LF}^c \zeta^c, c \in C \quad \text{(A 24a)}$$

$$X_{LF}{}^c = \frac{a_{LF}^c (1 - mps^c) Y^c}{PQ_{LF}} + \frac{PQ_{HF}}{PQ_{LF}} a_{LF}^c \zeta^c, c \in C \quad \text{(A 24b)}$$

$$X_O{}^c = \frac{(1 - a_{LF}^c - a_{HF}^c)}{PQ_O} (1 - mps^c) Y^c, c \in C \quad \text{(A 24c)}$$

Subject to the household budget constraint:

$$\sum_{m \in M} PQ_m \bullet X^c{}_m = (1 - mps^c) Y^c, c \in C$$

Savings and investment

$$S^c = mps^c * Y^c, c \in C \quad \text{(A 25)}$$

$$QINV_m = qinv_m * IADJ \quad \text{(A 26)}$$

$$FSAV + \sum_{m \in M} PQ_m * QINV_m = \sum_{c \in C} mps^c * Y^c \quad \text{(A 27)}$$

Foreign trade

$$QQ_m = aq_m CES(QM_m, QD_m) \quad \text{(A 28)}$$

$$QX_m = at_m CET(QE_m, QD_m) \quad \text{(A 29)}$$

$$\frac{QQ_m}{QD_m} = (\frac{PD_m}{QM_m} * \frac{\delta_m{}^q}{1-\delta_m{}^q})^{1/(1+\sigma_m{}^q)} \quad \text{(A 30)}$$

$$\frac{QE_m}{QD_m} = (\frac{PE_m}{PD_m} * \frac{1-\delta_m{}^t}{\delta_m{}^t})^{1/(\sigma_m{}^t-1)} \quad \text{(A 31)}$$

$$PM_m = pwm_m * EXR \quad \text{(A 32)}$$

$$PE_m = pwe_m * EXR \quad \text{(A 33)}$$

$$PQ_m * QQ_m = PD_m * QD_m + PM_m * QM_m \quad \text{(A 34)}$$

$$PX_m * QX_m = PD_m * QD_m + PE_m * QE_m \quad \text{(A 35)}$$

$$CPI = \sum_m v_m * PQ_m \quad \text{(A 36)}$$

$$PPI = \sum_m \mu_m * PI_m \quad \text{(A 37)}$$

Equilibrium conditions

(a) *Demands equal supply for factors*

$$\sum_{i\in B} LR_i{}^* + \sum_{po} LR_{po}{}^* + LR_U{}^* / \tau + \sum_{c\in CR\cup CF} \varphi^c = \sum_{c\in CR} L^c \quad \text{(A 38)}$$

$$\sum_m LU_m{}^* = L^U \quad \text{(A 39)}$$

$$\sum_{i\in B} A_i{}^* + \sum_{po} A_{po}{}^* = \sum_{c\in C} A^c \quad \text{(A 40)}$$

$$K_L{}^* + \sum_{c\in CR\cup CF} K_H^c + \sum_{po} K_{po}{}^* + K_O{}^* + \sum_{c\in CR\cup CF} \psi^c = \sum_{c\in C} K^c \quad \text{(A 41)}$$

(b) *Demands equal supply for goods*

$$\sum_c X_m^{c*} + QINV_m = QQ_m \quad \text{(A 42)}$$

$$X_{po} = QXI_{po} \quad \text{(A 43)}$$

Current account balance for ROW (in domestic currency)

$$\sum_m PE_m * QE_m = \sum_m PM_m * QM_m + FSAV \quad \text{(A 44)}$$

Endogenous variables

wr_R , wr_U , wu , t , r	Price of factors
PX_i	Producer price of activity *i*
PXI_{po}	Producer price of intermediate product
PQ_m	Price of composite good
PD_m	Price of domestically produced good for domestic market
PE_m	Export price in domestic currency
$AC^\dagger$	Average cost of high standards processor
$\prod^c$	Profit for high standards farming to agent *c*
$\prod^{poH}$ †	Profit for high standards processor
γ^c	Endogenous share parameters of transferred profit from corporate farms
β^c †	Endogenous share parameters of transferred profit from high standards processor
LR_i , LU_i , A_i , K_i	Demand of factor from activity *i*
X_{po}	Demand of intermediate input from processing sector *po*
$X_m{}^{c*}$	Consumption of commodity *m* by households *c*
QX_i	Domestic production
QXI_{po}	Production of intermediate input in processing sector *po*

QQ_m	Domestic demand for composite good
QD_m	Domestic demand for domestically produced good
QE_m	Export
Y^c	Income of households *c*
YF_b^c	Factor income of households *c* from factor *b*
$IADJ$	Investment adjustment factor
$QINV_m$	Quantity of investment demand for commodity *m*
CPI	Aggregate consumer price
PPI	Aggregate producer price
Exogenous variables and coefficients	
ϕ_i	Efficient parameter of activity *i* for different level of nests
$\kappa^c, c \in CR \bigcup CF$	Collateral of agent *c* in high standards farming
a_m^c	Share parameter of household consumption spending on commodity *m*
pwe_m	Export price for *m* (foreign currency)
pwm_m	Import price for *m* (foreign currency)
$qinv_m$	Baseline quantity of fixed investment demand
$\sigma_m{}^q$	Armington elasticities of substitution
$\sigma_m{}^t$	Elasticities of transformation
ν_m	Weight of commodity *m* in the CPI
μ_m	Weight of commodity *m* in the PINDEX
LR^c, LU^c, A^c, K^c	Household endowment
τ	Migration cost rate
mps^c	Marginal (and average) propensity to save for households *c*
φ^c	Fixed costs in the form of rural labor
ψ^c	Fixed costs in the form of capital
ε^c	Capital supply elasticity
ε_{poH} †	Perceived demand elasticity of high standards food
$FSAV$	Foreign savings (domestic currency)
Numeraire	
EXR	Exchange rate (dom. Currency per unit of for. Currency)
Functions	
CES	Constant elasticity of substitution function
CD	Cobb-Douglas function
CET	Constant elasticity of transformation function
Indices and sets	
i	Index for activities, $i \in I$
b	Index for intermediate sectors $b \in B = L \bigcup H$
po	Index for processing sectors $po \in LF \bigcup HF$
j	Index for factors, $j \in J$
l	Index for labor categories, $l = LR \cup LU$
c	Index for agents, $c \in C \bigcup CO$
m	Index for commodities, $m \in M$

Note: Differences from Table A3.1 are shown by †

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